VOLUME 43, NUMBER 1, MARCH 2020

HADRONIC JOURNAL

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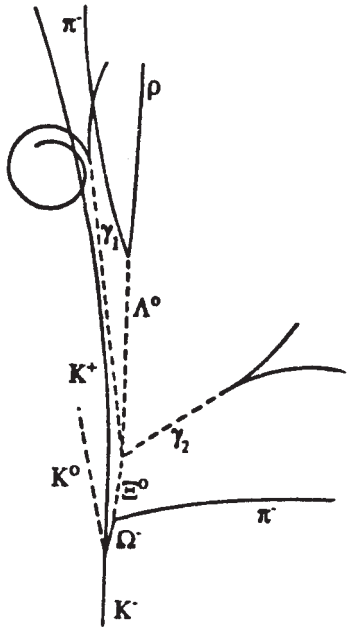

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HADRONIC JOURNAL Volume 43, Number 1, March 2020

HADRONIC JOURNAL

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HADRONIC JOURNAL 43, 1 - 50 (2020)
DOI 10.29083/HJ.43.01.2020

PHYSICS OF THE RELATIVISTIC GIANT ATOM

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Received March 12, 2019
Revised January 7, 2020

Abstract

If we defined a sphere s, with a quantity of protons p, distributed homogeneously among much more number of neutrons n, and if we have a quantity equal the number one as; $\left(\frac{r_o}{r_c}\frac{p^{\frac{2}{3}}}{(\frac{n}{p})^{\frac{1}{3}}}\right) = (1)$

$$\therefore\ k\frac{e^2}{r_o}\left(\frac{r_o}{r_c}\frac{p^{\frac{2}{3}}}{(\frac{n}{p})^{\frac{1}{3}}}\right) = k\frac{e^2}{r_o}(1) = k\frac{pe^2}{r_s} = E \equiv E_o \equiv m_o c^2$$

(Where r_s is the radius of the sphere, while c is the speed of the electromagnetic energy but not real particle speed). This nonrelativistic equation describes the rest mass equivalent energy of the fundamental particle but defined by the new spacing r_c (in addition to its inertial description defined by its rest radius r_o). The hidden meaning here is condensation of the particles in this new rest state. This last equation realizes two results: first, it describes the particle in its rest state, so the sphere can absorb physically all the kinetic (electric and exclusive) energies, and second, it realizes the initial conditions: $m = m_o$ & $r = r_o$ (where the Coulomb's equation form is now fixed on the Einstein's form) hence, we may conclude an alternate relativistic solution in the form of $n = \gamma^2 n_o$

When we followed up physics of the giant atom we found complete coincidence between the estimated parameters of its orbit and the astronomic parameters of the solar system. This means that the solar system -in one of its primordial evolutionary stages- was a giant atom-like system, and in the same time gives documents for the correctness of physics of the giant atom.

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Introduction

In this paper we put the relativistic basis for the giant atom like system [1]. Before we go with the discussion we have to stress on that it may appear in the beginning of this long study that there is contradiction with the current knowledge like the constant speed of light, Pauli's exclusion principle, and like quantum physics, but as soon we would find that the study completely respects such facts. Also we have to remember all over this study that the final macroscopic state of the microscopic events inside the giant charge is the absolute zero energy except from a little quantity of energy. We would divide the discussion into two parts: the first would discuss physics of the relativistic giant baryon (or electron), and the second will discuss the solar system in its primordial evolutionary stage as giant atoms, where we would discover that there is complete coincidence between the estimated parameters of the orbits of the giant atoms and that of the solar system as a document for the past existence of the giant atom system.

Throughout the first part of this study we will find that the relativistic giant charge unit, like the giant proton unit (Compton sphere) having a quantity of elementary particles equal $n = 10^{21}$ would produce –under a defined physical condition- the alternative relativistic solution in the form of replication by copy and paste to appear as a giant proton (the adult) having quantity of particles equal $N = 10^{45}$. The careful mathematic manipulation with relativity would reveal that the relativistic particle mass (inside the giant charge unit) would not increase by its high speed (special relativity will not affect the mass of the elementary particle) but instead, the number of the particles is the one which increases (the substitutive relativistic solution would be in the form of increase the particles count from n *into* N). This means that the energies of the electric and that of the relativistic gravitational field u_G and also of the quantum state would be **withdrawn** giving finally a macroscopic rest state (the relativistic mass m = *the rest mass* m_o)

Explicitly, the process of self-replication is the relativistic alternative solution. So if you looked for physics of this unit you would convince that the rest state is the macroscopic net state, or you can put the growth action in place of the motion action. This study stands on two physical bases. The first one is to put the Coulomb's form of the electrostatic energy in the form of the famous Einstein's equation of the rest mass of a fundamental particle, and incorporate the reduced Compton's wavelength $r_c = r_o(^{r_c}/_{r_o})$ as the spacing between particles where the rest radius of the particle = r_o

To guarantee that we deal with real matter, and to guarantee that the quantum speed -which is arising from this spacing- is less than the speed of light we mathematically derived this spacing as just a bit above r_c and consequently the quantum speed v just a bit below c. The second idea is to use the effect of the special relativity on the gravitational and electric energy u_g & u_e and also on the quantum energy u_c inside this sphere. To approximate this effect let us imagine a body has constant speed v, and on the same time it moves under the acceleration $a = dv/dt$, the relativistic gravitational force = $F_G = ma = m\frac{d}{dt}v/\sqrt{1-\beta^2} = \gamma^3 ma$

while the same body with the same v would hold relativistic electromotive force $F_e = ke^2(\gamma^2/r^2)$. Where, the charge e, is invariant. So, although the nonrelativistic F_e is much bigger than the nonrelativistic F_g yet the relativistic F_G may get equal to the relativistic electric energy. If such equality happened, suspense would occur.

The author stresses that; we have to be brave and accept the correct mathematic results whatever it may have suspense. The goal is to put the electric repulsive energy -per a proton- inside this sphere, in the Einstein's equation of the rest particle. Once this occurs then we get two results. The first is to search for alternative relativistic solution (other than the relativistic mass & length), and the second is that we succeeded, macroscopically, to abort –physically- the electric kinetic energy of the system. We –also- can find the equations packet which would abort physically the quantum exclusive energy due to the spacing between the particles.

1- The Compton's sphere in a rest state:

From the relativistic relation $m^2 = m_0^2/1-\beta^2$ *where* $\beta = v/c$, if the speed v of a particle $= c$ then the relativistic mass m would be infinite (refused), and if $v^2 = 2c^2$ then, $m^2 = -m_0^2$ (also is refused).

The Einstein's famous equation of the rest mass [2] of a subatomic particle like a proton (or neutron….) is defined by

$$k\frac{e^2}{r_o} = m_o c^2 \qquad (1)$$

Where, it is positive energy equating the relation between the inertial rest mass m_o of the particle and its rest mass equivalent energyE_o (where k stand for the electrostatic constant= $8.98 \times 10^9\, N.m^2/C^2$, e is the value of the elementary charge in Coulomb and r_o is the classic rest radius of the particle). If we multiplied the left side by the number 1 then the right side should be typically the same. On the same form, if we defined a system (neglect quantum mechanics for a moment) formed of quantity of protons p, distributed homogeneously among much more number of neutrons n, such that $\frac{n+p}{p} \approx n/p$ and if we defined the quantity

$$\left(\frac{r_o}{r_c}\frac{p^{\frac{2}{3}}}{\left(\frac{n}{p}\right)^{\frac{1}{3}}}\right) = 1$$

$$\therefore\ k\frac{e^2}{r_o}\left(\frac{r_o}{r_c}\frac{p^{\frac{2}{3}}}{\left(\frac{n}{p}\right)^{\frac{1}{3}}}\right) \equiv m_o c^2 \qquad (2)$$

We can see this equation as an umbrella and a physical (not mechanical) infinite potential barrier which conserves all the equations of the giant baryon as we will see.

Where the relativistic mass here –in this equation- $m = the\ rest\ mass\ m_o + 0 = m_o$ and consequently $r = r_o$ (If -and only if- the product inside the big brackets $= 1$ and

consequently, if $v = c = speed\ of$ the electromagnetic energy $e\,m.e$). Let us call this system "Compton's sphere". Now let us –also- multiply the electric field contributor of $e\,m.e$ of the rest particle by the number one, so let us define

$$\frac{1}{2}k\frac{e^2}{r_o} \times 1 = \frac{1}{2}m_o c^2 \times 1 \tag{3}$$

Mathematically, we can define any quantity of p and n, so let us –also- define another quantity

$$\left(\frac{r_o}{r_c}\frac{p^{\frac{2}{3}}}{\left(\frac{n}{p}\right)^{\frac{1}{3}}}\right) = \frac{1}{2} \tag{4}$$

Now again, let us -for a moment- neglect the relativistic & quantum effect and let us imagine that we have so big quantity of protons inside this Compton's sphere that the electric energy takes the form

$$k\frac{e^2}{r_o}\left(\frac{r_o}{r_c}\frac{p^{\frac{2}{3}}}{\left(\frac{n}{p}\right)^{\frac{1}{3}}}\right) \equiv \frac{1}{2}m_o c^2 \tag{5}$$

Equation 3 is intuitive operation, while (5) is nontrivial result.

We can see this equation as a physical description for the electric potential of the electromagnetic energy of a particle in a rest state (see appendix), and –also- we can see it as a physical description for the kinetic electric energy for each particle. But we have to notice that: the original relativistic solution describes the kinetic energy $u_e = \gamma m_o c^2 - \Delta m c^2$ while our alternative solution begins from the idea of equation 2 which describes the particle (definitely, inside our sphere) by non-relativistic mass (see later), so, we can formulate: $u_e = m_o \int v\,dv = \frac{1}{2}m_o v^2$

The important point –here- is to notice that the number one is not arbitrary mathematic number because it carries a physical meaning, so it could not –here- replaced by any other number. The number one when be multiplied by equation1 gives the physical meaning of the energy of a particle in a rest state, and when be multiplied by equation 3 it gives the physical meaning of the electric potential subdivision of this electromagnetic energy (half of the stored energy) of the particle in the same state. This means that multiplication by other numbers to get the same result is physically wrong. For example, we cannot multiply the left side of the first equation say, by o.1 to get in the other side rest particle with o.1 $m_o c^2$ (mathematics sometimes have to think as a physician). Also we have to notice that the two sides of each of equation 3 & 5 are synonyms, so to conserve this relation we have to do first. an added deficit quantity in one side have to be compensated by an added equal excess quantity in the same side, and second the same operations have to be hold on the other side of the equation. Also we have to notice that the equations which describe half of the rest particle are physically not independent equations because finally we have to describe a complete particle. So, such

equations should be considered as a temporary station just to describe the micro events of the macro-state. Hence, we can do a junction between Einstein's equation form, which talks about a particle in a "rest state" and Coulomb's equation form which talks finally about "relativistic mass". Since, this Coulomb's form takes the same form of Einstein's equation (if we neglected –for a moment- the original relativistic relations), so it is acceptable to carry the two meanings: rest mass and relativistic mass. When the two meanings are present in the same equation, then this may be explained by presence of "alternative" relativistic solution which affects something other than the rest mass. But the thing which acts against this coulomb's form is that, it carries the meaning of real speed $v = c$ which is -from the side of view of relativity theory- refused. So let us define infinitesimal small quantity with minus sign (deficit) and with positive sign (excess) and let this net zero quantity appears in equation 5 as follow:

$$\left(k\frac{e^2}{r_o}\left(\frac{1}{2}\right) - \frac{1}{2}k\frac{e^2}{r_o}\frac{n}{p\mu}\right) + \frac{1}{2}k\frac{e^2}{r_o}\frac{n}{p\mu} \equiv \frac{1}{2}m_o c^2 \qquad (6)$$

Where $\frac{n}{p}$ is the ratio between the two unknowns n *and* p while μ is another unknown, and all would be defined later. Since, we want to study physics of collection of particles in this Compton's sphere which has the highest possible kinetic (the electric & quantum) energy, then, the particle never get energy more than that defined in equation (6) and so, this equation could be considered the key for studying this case. But because $v = c$ is forbidden by the special relativity, so we need an infinitesimal cutoff, therefore, equation 6 appears with the deficit only as

$$k\frac{e^2}{r_o}\left(\frac{r_o}{r_c}\frac{p^{\frac{2}{3}}}{\left(\frac{n}{p}\right)^{\frac{1}{3}}} - \frac{1}{2}\frac{n}{px\mu}\right) = \frac{1}{2}m_o(\sim c)^2 \qquad (7)$$

This coulomb's form talks about a sphere which neglects each of the relativistic relations & the quantum effect and so it respects only the relativistic rule that $v < c$

But actually, this acquired speed is a microscopic picture, while the final form of our sphere obeys equation 3 or (2) so its macroscopic state is the rest state. So, $v = c$ is the speed of the electromagnetic energy (not speed of real particle), hence, it is not refused in this sphere (where $m_o c^2$ *means particle in a rest state*) .Therefore, the problem –here- which our system avoids is not $v = c$ but it is $v > c$

Fortunately, our alternative relativistic solution prevents $v > c$ but by the dynamics of equation 2 (where the particle appears in the rest state $m_o c^2$) or equation 6 where the particle appears in the rest state $m_s c^2$.

This problem arises from that; since the gravitational potential (u_g) never waste from matter then it would add energy to the energetic function of the system (this ambiguous sentence would be clear in the next sections) which means excess speed over c. Hence, the deficit

quantity which appears in the left side of (7) aims to avoid this problem. This is good news, because this means that the deficit in energy equals u_g which would help us to define the unknowns. Equation (6) carries the same description of equation (5) and could be considered its microscopic shape, while (7) was formulated to show and concentrate on this microscopic action. It is clear from the deficit inside equation 7 that it initiates the relativistic action. But each of the two equations in the above form is still describing the rest mass (no relativistic mass appears) so this form may carry the meaning of the alternative relativistic solution. Since the equation does not speak about external energy (it just describes the potential or its rest energy), so its inertial rest c^2 with that cutoff (deficit) appears as real speed. This speed would launch the relativistic action which appears if –and only if- we began from (7). This action –as we will see- would add first; excess quantity equal the deficit, so we go back to equation 6. And second, it would add the quantity D which is defined by equation 9 (see next) so we go back to equation 2 or 1 which is just describing a particle in a rest state which means that the relativistic mass is the same the rest mass. Hence, we are in an urgent need to the alternative relativistic solution. Finally, we would discover that the entire equations of this sphere are not more than description of the energy of the system in a rest state. Equation 2 could be written mathematically in the form of equation 6 as

$$\left\{\frac{1}{2}\left(k\frac{e^2}{r_o}-\frac{k\frac{e^2}{r_o}n}{px\mu}+\frac{k\frac{e^2}{r_o}n}{px\mu}\right)\right\}+\left\{\frac{1}{2}\left(k\frac{e^2}{r_o}-\frac{k\frac{e^2}{r_o}n}{px\mu}+\frac{k\frac{e^2}{r_o}n}{px\mu}\right)\right\}\equiv\frac{1}{2}m_oc^2+\frac{1}{2}m_oc^2 \qquad (8)$$

Let the second term= D, the excess quantity = b & the deficit = d

$$m_oc^2\equiv\left(\frac{1}{2}k\frac{e^2}{r_o}-\frac{1}{2}\frac{k\frac{e^2}{r_o}n}{px\mu}\right)+b+D=(a+b)+D=(f-d)+b+D \qquad (9)$$

If we delayed the definition of the spacing r_c to a next chapter, then equation 7 could be considered as a junction between Einstein's & coulomb's equation forms, from which we can declare launching physics of the giant atom. In the next chapter we would put in consideration the relativistic effect and then in a following chapter we would consider the quantum & uncertainty effect.

2- The rest particle inside a collection:

To conserve the initial conditions ($m = m_o$ & $r = r_o$) we need to fix the coulomb's form on the form; $k\frac{e^2}{r_o}=m_oc^2$ where the initial conditions are implied in this Einstein's form. Since, the factor c^2 does not imply real speed so this form of equation means abortion of the electric repulsive energy of the coulomb's form inside the Compton's sphere. All the micro-events which would appear in this study should be directed physically to realize –finally- the initial condition of the macro-state of equation 1, that is to say, we will choose -all over the study- the solution which realizes the rest state of the particle inside this sphere. It is the fatal mistake if we forgot this idea. If we want to talk about real speed and to avoid real speed

$v = c$ and –also- to initiate the action of physics of the sphere let the speed v of the sphere particles be close to c therefore, let us define $v \sim c$ where the deficit would appear as

$$v^2 \approx c^2 \rightarrow v^2 = c^2\left(1 - \frac{n}{px\mu}\right) = c^2\left(1 - \frac{1}{\gamma^2}\right) = c^2\left(1 - \frac{1}{c_o}\right) \quad (10)$$

This form talks about real speed so the electrostatic energy is so great that the relativistic relations are considerable.

Let us rewrite (6) as

$$\{\frac{1}{2}m_o c^2(1 - \frac{n}{px\mu})\} + \frac{1}{2}m_o c^2 \frac{n}{px\mu} = \{\frac{1}{2}k\frac{e^2}{r_o} - \frac{1}{2}\frac{k\frac{e^2}{r_o}n}{px\mu}\} + \frac{1}{2}\frac{k\frac{e^2}{r_o}n}{px\mu} \quad (11)$$

And let us in this chapter consider only the contents of the outer brackets of the two sides which are equivalent to (7). The goal here is to see how the relativistic action -due to the deficit- produces the "D" term and also to see the urgent physical need for the alternative relativistic solution. Since the left side of equation1 or 3 is a synonym to the right side, so adding a deficit and an excess quantity to the left side should appear –also- in the right side as in equation11. Actually (7) is the <u>firing equation</u> of the Compton's sphere. But since the final macroscopic state would appear in the complete form of equation 11 or 1 so we will see that the Compton's sphere is in complete rest state: the deficit quantity was a <u>deficit</u> in the rest mass of the left side of the equation and necessarily, a deficit of the rest energy of the right side, while the compensating excess term is the nonrelativistic gravitational energy which equals the equivalent energy of that deficit. This deficit in the equation is the **first block** in physics of the giant charge which will enable us to visualize the microstates of this equation. Now let us use the relativistic relations, so let us put

$\beta^2 = {v^2}/{c^2}$ And let, $\gamma^2 = c_o = \frac{1}{1-\beta^2}$

Where; $c_o = \varphi(v)$. Let us –also- define another unknown as; $\mu = \varphi(v)$,

$$\gamma^2 = c_o = \frac{1}{1-\beta^2} = \mu\frac{p}{n} \quad (12)$$

Where $\frac{n}{p}$ is constant.

$$\therefore m^2 = \gamma^2 m_o^2 = c_o m_o^2 = \mu\frac{p}{n}m_o^2 \quad (13)$$

This is the original relativistic solution with the expression of these unknowns. Of course, one of the goals is to derive the value of this speed v (& density of the matter of this sphere) and consequently the values of these unknowns. The physical meaning of the last four equations appears from the next section.

3- Global view:

3-1) Put the free particle described by equation 1 inside the collection described by equation 5. This gives a mathematic solution for the collection, but does not give the physical solution. If we have the sphere s, and its contents are conserved inside infinite potential barrier (equation 2) and if the particles oscillate inside the sphere, then according to the next equations 14 and 15, we can see relativistic gravitational potential $u_g(\gamma) = u_G \gg u_e(\gamma)$, and hence, the sphere would reach to equilibrium in a certain defined oscillatory speed defined by equation 10, as we will see. This idea can be the starting point of the physical solution. Now, we can define extreme electric initial speed as equation 10, and also, we can define nonrelativistic gravitational potential:

$$u_g = \Delta mc^2 = m_o \frac{c^2}{c_o}$$

And from equation 12 we can get: $u_g = \Delta mc^2 = m_o \frac{c^2}{c_o} = m_o c^2 \frac{n}{px\mu}$

Hence, we understand that we can control and define the arbitrary quantities inside the sphere where finally we get

$$u_g = \Delta mc^2 = m_o \frac{c^2}{c_o} = m_o c^2 \frac{n}{px\mu} = \frac{k\frac{e^2}{r_o}n}{px\mu}$$

And hence, we can understand the physical meaning of equations 6 –11.

3-2) Equations 20 – 27, can discover the mathematics of how each of u_G and u_e looks as:

$\frac{1}{2}m_o(c^2 - \frac{c^2}{c_o})$, and how they add:

$$u_G + u_e = u \equiv m_o(c^2 - \frac{c^2}{c_o})$$

3-3) This sphere represents a bound system. The bound system has a lower potential energy than the sum of its constituent parts. Its mass must be less than the total mass of its unbound constituents. In a separate section we would define the potential energy which binds the constituents of the sphere. If we looked to this sphere as a large nucleus, then all the energies –of the **semi-empirical mass model**- vanish, except the asymmetry and the *C*oulomb terms, in addition to the new term which is extremely considerable here in this very great nucleus. We would see how both, the electric repulsive and the quantum exclusive energies are aborted inside this sphere. The future -as we will see soon- carries something bad for the compound $u_G + u_e$. This u_G will represents something other than the gravitational potential u_g. This means that the particle mass should lose a little bit.

The rest-particle mass after missing Δm would become m_s($not\ m_o$)

$$(m_o - \Delta m) = m_s = (m_o - \frac{m_o}{c_o}) = m_o(1 - \frac{1}{c_o})$$

By the law of conservation of energy, the system energy of equation 2 remains comstant

$$\therefore v^2 = c^2\left(1-\frac{1}{c_o}\right) \div \left(1-\frac{1}{c_o}\right) = c^2$$

$\therefore u = (m_s c^2) \equiv m_o c^2\left(1-\frac{1}{c_o}\right)$. This is the intrinsic property of this magic sphere!!!

The cardinal idea is that; the factor that acts upon u to conserve it, is the same factor which converts v^2 *into* c^2 or, the deficit in the mass due to the gravitational binding energy $\equiv$ the excess in $v^2 \rightarrow c^2$

Hence, we can recall equation 2 to understand what the information which it carries. It say's: if $v^2 = c^2$ like $(m_s c^2)$ then, it is -like equation 1- zero kinetic energy, such that, the energy which appears is rest energy (zero speed). So, the sphere succeeded to abort u: the original relativistic relations vanish, and replaced by alternative relativistic relations defined by equation 22 and 56.

It must be clear that the term b -which appeared in equation 9 and which appears in other positions of the text- acts on u by the above dynamics (by conservation of energy) not by else. Hence, we can again recall equations 6 – 9 to understand how the term $b = u_g$ (where u_g is a negative quantity) acts with the conserved term u

$$\left\{k\frac{e^2}{r_o} - \frac{k\frac{e^2}{r_o}n}{px\mu}\right\} + \frac{k\frac{e^2}{r_o}n}{px\mu} = \left(k\frac{e^2}{r_o} + u_g\right) - u_g = m_s c^2 + u_g \equiv m_o c^2$$

Appearance of the term $m_s c^2$ is enough to convince that equation 2 is realized and u is aborted (it was transformed into rest energy). The two terms $m_s c^2 + u_g$ mean that we have got the particle which is defined by equation 1, but inside a collection. If you want the same free particle -defined by equation 1- to appear here, then we can add the sign of equivalency. The confused point here is that, if the relativistic u_G had been aborted with its conjugate u_e, hence we can ask about how u_g could be precipitated in the system. The answer you can find it in section 9.

It is clear that the quantity $m_s c^2$ which appears always with the summation $(u_G + u_e)$ it is not –at all- the same original rest energy, although, it describes the original rest mass. Therefore, we have to distinguish between the inertial (internal) rest energy of the same original rest particle and the rest energy of the system which represents the subject of this article. Where did the kinetic energy go? Here is the answer:

We have two functions: one describes constant real speed, while the second describes zero speed-state. Both should appear in a general solution. According to the original relativity, the kinetic energy appears as: $m_{(v)}\varphi(v) = m_o \oint_o^v \gamma v dv$, while it appears in the alternative solution in the form

$m_o\varphi(v) = m_o\left(\frac{0+v^2}{2}\right) = \frac{1}{2}m_o v^2$. As you see, in this alternative solution, each of the mass and the speed is a constant and is neither a continuous nor a differential function. Hence, we can conclude: the general solution -which adds the two solutions-, represents a particle bouncing forth and backward -inside its defined space- between two points each with infinite potential. We need a discontinuous function to represent a harmonic but not simple motion (not sinusoidal):

$$\dot{x}(t) = 1v \; : \; [\,0 < t < \tfrac{T}{2}]$$

$$= -1v \; : \; [\,T > t > \tfrac{T}{2}]$$

$$= c \; : \; t = \{\tfrac{T}{2}, T\}$$

Such that c represents the zero state (rest energy), while $v = c\sqrt{(1 - \frac{1}{c_o})}$.

The upper case letter describes the time of the oscillatory motion $T = \frac{r_c}{v}$

The last solution carries the meaning of $v^2 = c^2$ which first, can -by the addition to the original rest energy of the particle $(m_o c^2)$ – realize (as we will see) the general solution $v^2 = 2c^2$ and second, could be considered as the macroscopic state or the boundary condition which should strictly define the first two microscopic sates. Hence, we have:

$$S = \gamma^2 s\,, \quad \bar{m} = m, \; \bar{x} = x$$

3-4) *From all above, we can summarize: the particle inside this magic sphere appears as a 'paper' formed of two faces.* The particle itself looks as a point while the remainder of the surrounding is the energy of the system. *On a face of the paper is written:*

Special relativity –here- and only here, is constrained by equation 1, therefore; the repulsive and the exclusive energies are aborted and consequently, the original relativistic relations are –also- aborted. This means constant density of matter.

While on the second face is written:

$$u_e = \frac{1}{2}m_o c^2(1 - \frac{1}{c_o})$$

$$u_G = \frac{1}{2}m_o c^2(1 - \frac{1}{c_o})$$

$$u = u_e + u_G = m_o c^2(1 - \frac{1}{c_o})$$

Now, let us divide the sphere into two sub-spheres.

4- The relativistic protons potential well& the approximate solution:

Now, let a defined quantity of protons in a defined density of nucleons to allow each proton to gain the above defined speed $v \approx c$ (due to the electrostatic action) and let –also- the density of the same sphere allows each neutron to gain the same $v \approx c$ as quantum speed (due to the relative spacing $r \approx r_c$), then the relativistic gravitational energy as speed function $u_G(v)$ would be affected by the speed v more than the electric kinetic energy $u_e(v)$ such that the factor $\frac{1}{\gamma} = \sqrt{\frac{1}{c_o}} = [1- \left({v^2}/{c^2} \right)]^{1/2}$ appears in the denominator of the relativistic gravitational potential (it is not actually potential as we will see soon) energy per a proton $u_G(v)$ with power $3/2$ while it appears in the denominator of the electric potential energy per a proton $u_e(v)$ only with power $1/2$

$$u_G = -Gn(m_o^2 c_o)\left(c_o^{1/2}/r_s\right) \tag{14}$$

$$u_e = kpe^2 c_o^{1/2}\Big/ r_s \tag{15}$$

Where; r_s is the radius of the sphere & G is the universal gravitational constant. As we saw in the beginning of this section -and to realize equations 2 & 5- (we would see later that the magnetic moment energy of the sphere is close to zero, therefore u_G would replace it to realize the intuitive mathematic solution) there should be a form of equality (that is to say, we are searching for the conditions required for this equality) appears in the form

$$-Gn(m_o^2 c_o)\left(c_o^{1/2}/r_s\right) = k\frac{pe^2 c_o^{1/2}}{r_s} \tag{16}$$

The right side of this equation represents the electric energetic function which should appear -in the Compton's sphere- in a rest form (one half of a particle in a rest state) while the left side represents the second half of the rest particle (see the appendix).

From the Einstein's equation form, the condition:

$$m = m_o \;\&\; r = r_o \tag{17}$$

is realized only at $k\frac{e^2}{r_o} = m_o c^2$ Because we began from the outer brackets of (11) -which carries the relativistic meaning- and not perfectly from (1) so we would consider (17) is a proposal realized only at existence of the terms b & D defined in (9), and hence we would deal with the next equations on this base where later on we will study how the excess term is deposited in the equation. Let us now see how the term "D" is added.

Since we are committed by the intuitive operation described by (2) and (3) which describes the electromagnetic energy density which is formed of two halves, one of them is the electric subdivision as in (2). For a reason we will discuss in the next section, the magnetic energy is not fit to represents the second subdivision, so we have to search for an alternative one. The

relativistic gravitational potential as in (14) can be. But the relativistic electric potential as in (15) would violate (2) and moreover violate the fact $v < c$, therefor we have to do algebraic simplification of the two halves in the equality (abbreviations on the factor c_o) where finally the equality appears after simplification as

$$k\frac{e^2}{r_o}\left(\frac{r_o}{r_c}\frac{p^{\frac{2}{3}}}{(\frac{n}{p})^{\frac{1}{3}}}\right) = \left(-Gc_o\frac{m_o^2}{r_o}\right)\left(\frac{r_o}{r_c}\right)n^{2/3} \qquad (18)$$

Where c_o is the equality factor (defined from eq. 12) and acts in this equality by a vague process would be determined latter and the negative sign means that the two sides act opposite to each other. The solution in the form of asymmetric addition is;

$$A + -A = 0 \qquad (19)$$

Let us search for other solution and so go back again.

Let us recall the equality; $k\frac{e^2}{r_o}\left(\frac{1}{2}\right) = -Gc_o m_o^2\, n/r_s$

Put $(-m_o^2)$ as a relativistic equivalent to m^2 (proposal should be realized). Although this is original (as we will see) but imaginary solution yet we would choose it because it is the one which realizes equation 1(as we will see soon).

$\therefore\ m^2 = (-m_o^2)$ is a proposal should be realized (20)

Rewrite (18) in its simplified relativistic form

$$\therefore G(-\gamma^2 m_o^2)\frac{n}{r_s} = k\frac{e^2}{r_o}\left[\frac{r_o}{r_c}\cdot\frac{p}{(n)^{1/3}}\right]$$

The two equalities are now not literally gravitational and electric potential, although we can sometimes call them metaphorically relativistic potentials because their origin is potential. Anyway, the accurate description of the sum of these subdivisions is the rest energy which expresses perfectly equation 1 which reflects the alternative relativistic solution as we will see soon.

By substitution of (12), (20) and (4) in (18)

$$\therefore \frac{Gm^2(nc_o)}{r_s} = k\frac{e^2}{r_o}\left[\frac{r_o}{r_c}\cdot\frac{p}{(n)^{1/3}}\right] = k\frac{e^2}{r_o}\left(\frac{1}{2}\right) \qquad (21)$$

Since, $m = m_o$ therefor c_o has physical concept which must appear as:

$$\frac{Gm^2(nc_o)}{r_s} = k\frac{e^2}{r_o}\left(\frac{1}{2}\right) \equiv \frac{1}{2}m_o c^2 \qquad (22)$$

Since, n is the counting of the neutrons, but we want the actual counting of the nucleons (where $n \gg p$) and so putting the actual count of the nucleons gives:

$$\frac{Gm^2[(n+p)c_o)]}{r_s} = k\frac{e^2}{r_o}\left(\frac{1}{2}\right) \equiv \frac{1}{2}m_o c^2 \qquad (23)$$

The middle side of this equation –like the left- has become positive energy, such that each side is –now- possessing the same magnitude and the same positive form of $\frac{1}{2}k\frac{e^2}{r_o}$ therefore the equality has –now- symmetric additive solution as

$$u = u_e + u_G = \frac{1}{2}m_o c^2 + \frac{1}{2}m_o c^2 = m_o c^2 \qquad (24)$$

The term D is –now- deposited in the additive form where each term of the left side represents the value of the energy of u_e & u_G These terms are no longer electric and gravitational energies, but reversely, their sum is the rest energy which swallows these energies (if we forget for a moment this description we will fall in great confusion).

This equation does not describe a new created particle but it describes the Compton state energy (per a proton) –definitely- in a rest state, as equivalent to the right side of the equation, so it is a new description (originating from the Compton state) of the rest particle which when be added to its inertial description we get:

$$m_o c^2 + m_o c^2 = m_o 2c^2 \qquad (25)$$

Equation (25) describes the total rest states (0 + 0). So the proposed equality (20) has a solution appears simply from (25) and also has a relativistic concept in the form;

$$m^2 = {}^{m_o^2}/_{1-\beta^2} = {}^{m_o^2}/_{1-2} = -m_o^2 \qquad (26)$$

And from (26) it has an original relativistic solution as

$$v^2 = 2c^2 \qquad (27)$$

Equation 23 is the simplest form regarding the factor c_o therefor it is the correct form which shows the correct relativistic alternative solution. Equations 23 – 27 act as one packet. Equations (27&25) are synonyms where they represent the condition required for existence of the giant charge where such state does **not** mean $v > c$ but it rather says that the particle is in a rest state but this state is defined by its Compton state as it is defined by its intrinsic properties (0+0), or it definitely means relativistic solution for the proposal: $m^2 = -m_o^2$ where the negative sign of $-m^2$ does not mean direction but it is an operator has a radical physical meaning such that it converted the kinetic electric & the relativistic gravitational energies in the equality of equation 22 into conjugate pair (this expression means –all over the

study- equation 24) of the rest energy (the next section of this study will give further clear meaning for this imaginary factor). Anyway, the **second proposal** is now realized but if -and only if- equation 27 was realized or definitely, if the term b was deposited in the equation. The same equality of (20) when takes place in (18) -after understanding the physical meaning of its negative sign- leaves behind, the conclusion:

$$m^2 = -m_o^2 \rightarrow m^2 = m_o^2 \rightarrow m = m_o \,\&\, r = r_o$$

But this conclusion appears **only** inside (22) and the equations derived from it. So equation 23 -which is the simplest form and which engulfed physically the negative sign of the proposal of equation 20- is the one which realizes excellently the initial condition which is discovered by equation 24, so it is the one which carries the alternative relativistic solution. Implicitly, when equation 20 takes place in (18) and when the symmetric addition takes place in (24) which carries the meaning of $m = m_o$ then, we are **in urgent need** to alternative relativistic solution and –also- we are still in the correct extension of equation1. But since our equations are built on the hidden deficit of equation 11 where we saw only its relativistic action arising from $v \sim c$ or arising from the speed defined by equation 10 so we would consider the obtained results need the correcting term b appears with (7) to compensate that deficit. Till we discover this missed term we will consider the result of equation 24 as an approximate solution. This correcting term and the dealing with equation 7 not 6 (with $v \approx c \; not \; v = c$) would appear in a separate chapter titled the deficit & excess. Now let us go on with the alternative relativistic solution.

Equations 20 &27 realize each other in the special relativity and represent the **second block** in the giant charge physics.

Now from equation 23 we can write the original relativistic mass in the form of:

$$[(n_o + p_o)c_o]m_o^2 \equiv (n + p)m_o^2 \quad where \; m = m_o \tag{28}$$

A new terminology can correct any misunderstand. So we can put the **reproductive** energy or the rest energy of the system in place of the kinetic energy. Dividing the two sides of equation 22 over p discovers the factor μ which appears (independently from equation 12) as

$$\mu = c_o \left(\frac{n}{p}\right) = \frac{(c_o\, n)}{p} = \frac{N}{p} \tag{29}$$

Since; $\frac{n}{p} = constant$

$$\therefore c_o = \gamma^2 = N/n = P/p \tag{30}$$

Where; the capital letters $N \; and \; P$ are the 'relativistic' number of the neutrons and protons of the giant proton (the adult) while the small letters $n \; and \; p$ are the 'rest' number of the neutrons and protons of the giant proton unit (the zygote- like unit). Actually, the relativistic dilatation of the particle number is not strange in physics: as the velocity of an observer

relative to an emissive surface increases the number of photons (due to time dilatation) encountered by the observer per unit area per unit time (intensity).

5- Physics of Compton's sphere:

1- Equation 2 describes the particle in a rest state by the energetic functions of the Compton's sphere (in addition to its inertial energetic functions) so the final result is a rest particle defined by the intrinsic properties of Compton's sphere (the new rest spacing r_c) in addition to its rest radius r_o

2- Since the rest particle is defined by its electric & magnetic fields, and since the superposition of the charges of the particles is the origin of the charges of the collection, so the sphere (collection) has electric flux:

$\emptyset = \oiint \mathrm{E}.\ \mathbf{n}\mathrm{ds} = \nabla.\mathrm{E} \iiint \mathrm{dV} = \frac{\mathrm{Q}}{\varepsilon}$ *Where* **n** *(in this & the next equation) is the unit vector in the outward direction of the sphere. And has magnetic flux*:

$= \oiint \mathrm{B}.\ \mathbf{n}\mathrm{ds} = \nabla.\mathrm{B} \iiint \mathrm{dV} = 0 \rightarrow \nabla.\mathrm{B} = 0$ This means no magnetic charges inside the sphere, so we need a flux to replace that zero flux. Hence, the flux of the conservative gravitational energy u_g can perform this role. But since the particles are oscillatory moving so this u_g would appear as $\mathrm{u_G}$ (you never forget that Compton's sphere energy is a copy from equation 1, so its entire equations should go straight forward with this equation.

The goal in this point was to define so great speed that $\mathrm{u_G}$ can represent the half of the energy of a rest particle. This was done by choosing defined number of particles within defined density (as we will see in the next sections).

3- Since, we need to realize equation 2 (the initial conditions) so, we have to do algebraic simplifications on $(c_o)\ of\ (m_o\ \&\ r_o)$,hence, we got equation 22 where each of the left & the right side is fixed on $\frac{1}{2}m_o c^2$ which when be added together we can get a description of a rest particle.

4- After all, equation 22 leaved behind; $n = c_o n_o$ which means relativistic replication (self-repetition) with the same density to conserve the initial condition $(r = r_o)$

5- If a particle moved in speed v (the motion inside our sphere comes from equation 10) then the linear mass density; $\frac{m}{r} = (\gamma m_o)(\frac{\gamma}{r_o}) \equiv (\gamma^2 m_o)\frac{1}{r_o}$

So, this may carry a hidden relativistic meaning appearing as creation of new rest particles (If -and only if- we were inside equation 2) counting $n = \gamma^2 n_o$. Equation 22 goes straight forward to realize the initial condition so it defined well the alternative relativistic solution as in equation 28.

6- The strategy of equation 22 is that; since equation 2 is the final macro state so m_o & r_o of equation 22 should be eliminated from c_o where each side of the equation is equivalent to $\frac{1}{2}m_oc^2$

7- We have to notice that the algebraic simplification makes u_G of equation 22 & 23 not thoroughly expressing the relativistic gravitational energy described by equations 14 and 18, but it is rather the alternative relativistic gravitational rest energy describing (with the alternative relativistic electric energy u_e) the rest energy of the rest particle -which is described by equation 24- inside the sphere. Also we have to notice that creation of particles here is relativistic self-repetition. Because the term $u_G(\gamma)$ is a function in γ so it is relativistic. And because it is derived from the packet of all the above equations as a function in the gravitational energy $u_G(\gamma) = u_g\gamma^2$ so it is gravitational. But because it is derived from the same equations as; $u_G(\gamma) = u_g\gamma^2 = G\frac{m^2}{r_c n^{1/3}}(n\gamma^2)$ so it is not absolutely the typical potential. Thereafter, we should call it relativistic gravitational rest energy which with its conjugate: u_e (or u_c as we will see) would construct the rest energy of the system $u_G + u_e \equiv m_oc^2$. Henceforth, we should discriminate between the term u_G and the potential $u_g(N)$ which is alternative relativistic because it is a function in $N = n\gamma^2$ while it is potential because it is written in the form $u_g(N) = -G\frac{m^2}{r_c(n\gamma^2)^{1/3}}(n\gamma^2)$. Here you notice that it is a negative term with denominator formed of the real radius of the relativistic sphere (you will see astronomic application in equations 74 - 76). The rest energy ,all over the article, means the additive conjugate $u = u_G + u_e \equiv m_oc^2$ which is the energy of the system when be distributed all over the particle which means rest energy per a particle which ,consequently, when added to the inertial internal rest energy of the particle we get equation 25 which is equivalent to (27) which ,consequently realizes equation (20) whose negative sign is absorbed physically in (28) to realize ,finally, the condition $m = m_o$ which realizes equation 1 which means abortion of the kinetic energy of the system. The particle is now defined (after the additive process) by the rest state (0 + 0), which means no motion and so no relativistic relation. To fire the relativistic relations we defined the Compton rest state of the particle to appear as $m_o\{(c^2 + \varphi(u_g)\} - m_o\varphi(u_g)$ such that the contents of the outer brackets of the left term when be add to the squared speed arising from the gravitational energy we get complete rest state (neither above nor below). The squared speed $v^2 = c^2 + \varphi(u_g)$ is the one which fired out each of the relativistic relations & the micro-events which we studied in all the above equations, (remember that u_g is a negative quantity). But these microstates are constrained by the final rest state $m_o\{(c^2 + \varphi(u_g)\} - m_o\varphi(u_g) \equiv m_oc^2$

8- Equation 25 does not mean neither description of two particles nor production of a new particle where (25) is defined by (27). So Self repetition means neither transformation of energy into new particle nor creation of particles by collision. But it means –here- alternative relativistic solution.

9- If we treated our sphere as in the semi-empirical model then the above is the coulomb's term while the others would be discussed step by step.

10- After all, equation 2 does not add a new particle, but it describes (new) rest energy originating from the Compton's sphere (per a rest particle) exactly as equation 1 describes the rest mass of the rest particle

11- Since the electromagnetic energy density describing the rest particles is constant and does not obey the superposition (if we have a proton among a collection of protons inside a sphere, then each proton is still possessing rest energy defined by $E_o = m_o c^2$ whatever the central electric energy of the collection may be), and because each of the conservative energies here is describing rest energy so it is – also- constant & does <u>not obey</u> the superposition. Hence, once each side of the equation -which is describing the rest particle-, is equal $\frac{1}{2}m_o c^2$ then it would not obey the superposition. If the left side of the equation went straightforward with the conservative electric energy then it had to be multiplied by $P\ not\ p$ but since it became describing the rest energy of the particle so p which realizes $E_o = m_o c^2$ is the correct. If this answer was not enough and if we asked about the fate of the electric energy of the ratio $\frac{P}{p}$ then we can give the next explanation. Put $P = pc_o$ instead of p in the nominator of the left side of the equation then $u_e = \frac{1}{2}m_o(c^2 c_o)$.

Although this is contrasting with the current knowledge but let us go on to see that our solution refuses this incorrect speed. Now we want to see the relativistic effect of the speed $(c^2 c_o)$ on the number of the particles P so it is considered rest number, so if we put the relativistic number P_r inside the alternative relativistic solution (28) and since the initial conditions -which appear in (27)- then we get

$$m^2 P_r = \frac{P m_o^2}{1-\frac{c^2 c_o}{c^2}} = (-m_o^2)\frac{P}{c_o} = (-m_o^2)p \quad \text{Such that } c_o \gg 1$$

Where, the minus sign has a final physical meaning realized by equations 25 & 27. This means that the alternative relativistic solution returns $P \to p$ & $E_o = m_o c^2 c_o \to E_o = m_o c^2$. This is a critical point and <u>should</u> be understood well, otherwise it leads to misunderstand. Equation 1 describes E_o of the rest (not the relativistic) particle. Each E_o defines a certain space and does not traverse to the space of the other particle. Since equation 1 & 2 are synonym then, $u_e + u_G = u \equiv E_o \equiv m_o c^2$ and again these u(s) do not traverse to each other. And again, since (1) & (2) are synonym then replication of the particles means also replication of these conjugates(u), which means repetition of the Compton's sphere as a copy & paste (with the same density of matter & the same particle rest energy). By other words,

each $u = E_o = 0.752 \times 10^{-10} j$ (the 'physical secretion' of the particles) is blocked & inhibited (and so, not traverses each other). The conjugate $u_e + u_G$ after adding u_g (as it is represented in equation 8) where equation 2 is fixed well on equation 1 we get the same particle (which is defined by equation1) with the new additive r_c definition (as in equations 25 & 27). Explicitly, energies of the sphere -itself- appear as summation of quantities, each is equivalent to $m_o c^2$ (rest form) which when be added to $m_o c^2$ of the particle realizes the entire equations of Compton's sphere.

This addition –after the physical engulf of the negative sign (which appears with m^2 *in the original relativistic solution*) by equation 22- leaves behind the relation $m = m_o$ hence, we need alternative relativistic solution. This appears as repetition of equation 1 by the repetitive factor $c_o = \gamma^2$. Again and again we have to stress on that both u_e & u_G represent nothing more than the rest energy of the system per a particle as in 24. This meaning is the physical mechanism of abortion of all the kinetic energies inside the sphere.

12- The physical meaning of each of the new extra definition of the rest macro-sate of the particle (inside our sphere) which is defined by r_c *and the physical meaning of the imaginary factor which is plugged in equation 21 would be more clear from the next study of the wave function of the particle. The particle inside our sphere is defined by* $c^2 + \varphi(u_g)$ *which describes a real motion (oscillation) and also defined by;* $c^2 + \varphi(u_g) - \varphi(u_g) = c^2$ *which is the macro-state as explained by equations 1, 2, 26 & 27.*

Since solution of Schrödinger equation (1D) for a particle inside infinite potential well takes the form of; $\Psi = A\sin(kx) + B\cos(kx)$ *where* $B\cos(kx)$ *is a zero term*

$$\therefore \Psi = A\sin(kx) = A\sin(\tfrac{p}{\hbar}x) = A\sin(\tfrac{mv}{\hbar}x)$$

13-a) Speaking about the relativistic function and the real speed of the particle then we would have the alternative relativistic relations defined by equation 28. Therefor;

$x = x_o$, $m = m_o$ & $m\,n = m_o(\gamma n_o) = m_o(n_o\sqrt{c_o})$ *The factor* $\sqrt{c_o}$ *is integer acts - mathematically- on the angle* θ *of the above function as a repetition factor. So the relativistic wave function appears as* $\Psi = A\sin(\tfrac{mv}{\hbar}x) = A\sin(\tfrac{\sqrt{c_o}\,mv}{\hbar}x)$

∴The function returns again to its common form; $\varphi = A\sin(\tfrac{mv}{\hbar}x)$ *which runs straight forward with the common solution.* $\rightarrow < x >= \tfrac{1}{2}l = r_c$

This solution treats the particle as a point moves really forward from 0 *to* L *and backward in the opposite direction. But finally the particle looks in the mid-point. (It is better to say that* r_c *carries here the meaning of the spacing not the rest radius of the particle (The energy density is explained in a next section).*

13-b) the next goal is to show that the zero term of the wave function solution has physical meaning for the particle inside our sphere. So, we would search in how this zero term (of the wave function, 1D) realizes the new extra definition of the rest particle inside our sphere. This extra definition needs describing the relativistic mass by (26) where the imaginary factor appears as; $m = im_o$ *to describe the rest energy state defined by (27).*

$\therefore \Psi = A\cos(kx) = A\cos\left(im_o\frac{v}{\hbar}x\right) = A\cos(ikx)$. *From the trigonometric identity;*

$\therefore \cos(i\theta) = \frac{1}{2}(e^{-\theta} + e^{\theta})$ *To solve this equation we need to understand the physical meaning of this case. If the case satisfies no motion then* x *is constant and the integration is transformed into simple multiplication.*

$$\therefore \; < x >= A^2 \int_0^L \Psi^* \, x \, \Psi \, dx \equiv \frac{A^2}{4} x \sum_{\Delta l}\left(e^{-\theta} + e^{\theta}\right)^2 = \frac{A^2}{4}\left(e^{-\theta} + e^{\theta}\right)^2 l$$

After normalization of $\frac{A^2}{4}\sum_{\Delta l}(e^{-\theta} + e^{\theta})^2$

$$\therefore \; < x > = l$$

The solution tells us that if l *is the length of the particle then its expected length is* l

Although it is a trivial solution yet it realizes equations 26 & 27.

This means that the first term $\sin(\theta)$ *of the wave function solution, first, describes the micro-event of the particle which is defined by the real motion* $\{c^2 + \varphi(u_g)\} - \varphi(u_g) = v^2 - \varphi(u_g) = c^2$ *where the contents of { } brackets represents this motion and gives the relativistic alternative solution defined by equation 28, and second it realizes the alternative relativistic solution (equation 28) where the repetition factor appears mathematically here as repetition of the angle*θ. *While the zero term of the same wave function realizes its rest macro-state - where* $\{c^2 + \varphi(u_g) - \varphi(u_g)\} = c^2$ *represents the rest energy- and hence, the imaginary factor of equation 26 is engulfed physically and finally appeared as a real physical meaning.*

14- The last point here is to know how the original relativistic solution takes place in the radial direction. Equation 2 can represent a physical (not mechanical) infinite potential barrier which guarantees the state; $r_c n^{\frac{1}{3}} = r_s$

If the motion of the sphere's particles occurs in all directions in the same time (like explosion or growth) then we can write the invariant event interval ds^2 as follow: $ds^2 = c^2dt^2 - dr^2 = c^2dt^2 - dx^2 - dy^2 - dz^2 = c^2(\overline{dt^2}) - (\overline{dx^2}) - (\overline{dy^2}) - (\overline{dz^2})$ where the primed terms stand for the moving coordinates. We can formulate the relativistic relations of the motion as follow:

$$c\overline{dt} = \gamma c dt - \gamma dx\frac{v_x}{c} + 0 + 0$$

$$\overline{dx} = -\gamma dt\frac{v_x}{c} + \gamma dx + 0 + 0$$

$$\overline{dy} = -\gamma dt\frac{v_y}{c} + \gamma dy + 0 + 0$$

$$\overline{dz} = -\gamma dt\frac{v_z}{c} + \gamma dz + 0 + 0$$

And finally, we can recall the properties of the metric tensor and write: $\overline{(r)}^2 = \gamma^2 r^2$

Again, because aborting this original solution, then, the alternative one should take place.

After all, we saw a 'physical snake' have engulfed the repulsive electric energy which appeared with the relativistic u_G as a conjugate pair. Once the initial condition was realized then we need a relativistic solution -other than the original one- which appears as equation 30. Microscopically, the events inside the Compton's sphere are fired up by equation 7 (where the real velocity$v = c + deficit$) or by the big brackets of equation 6 → the alternative relativistic solution passing through the entire packet of the equations from 7 till 68 and finally it should appear in the form of equation 1. Since, the macro-state of the relativistic Compton's sphere is no more than multiplication of equation one by the number one so you will notice that the macro-state of the entire packet of the equations from 1 till 96 (which describes the interior of the giant proton) obeys –macroscopically- the same rule (conservation of density of the states & density of matter, and so it describes forever the rest state).

Actually the sphere gives the solution as growth in the three dimensional space ,with the final constant density, from the initial sphere with the initial number of particles n *and* p -let us call it the giant charge unit (GCU) - till it reaches to the final sphere (let us call it the giant charge GC) with the final number of particles *N and P*. Or; (GCU) c_o = (GC). Hence, the goal -in this point- is to define astrophysical meaning for *N* such that the giant charge is fit to orbit. We need to understand the transformation of energy (actually, -as we will see- it is not passive transformation but it is relativistic solution) into matter in this alternative solution deeply and not superficially. We need the entire equations packet; we need the particles spacing r to be defined by a bit excess above r_c which gives quantum speed defined by a bit quantity below c. Also we need to pick up the relativistic imaginary solution and deal mathematically with it to find that $m = m_o$ once we found that the relativistic mass equal the rest mass then it is the beginning to choose the alternative instead the original solution. Before all the above, we need to define the speed -of particles- which depends on the unknowns μ & c_o which should be defined as we will see. Actually, the macroscopic picture of our sphere would be clear step by step. As we saw that u_G absorbs -physically- the repulsive effect of u_e also in the next chapter we will see that it absorbs the objections of the quantum mechanics. Now the GCU is formed of two distinguishable particles; the protons p and the neutrons n where $n >> p$. So, each of both has its specific distinguishable potential (inertial) well [3]. We saw that the proton in its potential well appeared as a pair of conjugate. Also the neutron does, so we are still scoping the micro-events.

6- The relativistic neutrons potential well (Asymmetry term):

Let us define the Compton's (reduced) wave length of a free neutron as;

$r \approx 2.09 \times 10^{-16}\, m$ [3]

And let the momentum to be defined as: $\hbar = mv\, r$ where v is the speed defined by equation 10, so let us incorporate this length in our sphere.

To define the spacing which estimates this v we have to consider two factors, the first is: since the particle is not free but is in a spherical collection so we have to define the energy density inside this sphere, and the second is the uncertainty effect. Since we need to realize the maximal possible expected speed which is just a bit beneath c then we expect that the spacing is actually a bit over r

Since $\Delta p \approx p \approx mc$ and if we treated this uncertainty as a real momentum then we should have the uncertainty $\Delta r = \frac{1}{2}r$. But since a particle cannot exist inside another particle so the real motion needs extra spacing, hence, the spacing $r_c = r + \Delta r = 1.5r$ and finally we divide this spacing over the factor defined by equation10 as

$r_c = 1.5r \div \sqrt{1 - \frac{n}{px\mu}} = 1.5r \approx 3.135 \times 10^{-16} m$ (Where, the factor under the root – quantitatively- is negligible as we will see).

1- Since the highest energy which anybody can acquire is $\frac{1}{2}mv^2 = \frac{1}{2}mc^2$ then the exclusion quantum energy (symmetry term) of any collection of particles (inside a closed system) never exceeds this highest energy and consequently its spacing never exceeds the above length. In the next discussion we will search in the exact required density which realizes the highest possible energy inside Compton's sphere where the initial conditions are realized

This density allows us to use the new expression; Compton's sphere instead of Fermi sphere. We expect that the density inside the sphere is in this range but the accurate value of the spacing should be defined from the density of the states of the collection. In GCU and because of $n >> p$ Pauli's term u_c of the Compton's sphere appears as predominant positive kinetic energy. For each neutron we have asymmetric (Pauli) term [4] on the same principle of the liquid drop model of the nucleus in the form of; $u_c(A - 2z^2)\ /A = u_c\ (n - 2p)\ /n = u_c$

(You noticed that number of nucleons A is given here in our model the symbol n and number of the protons Z takes here the symbol p)

In the Compton's sphere (on the same way of Fermi sphere) [5]; Pauli's exclusion Principle needs to multiply the count of the filled states by two (+/– spin). We need –also- to divide over eight [5] to get only the positive space octant (where $sin - kx = - sin\, kx$) So, we have the density of states $= n_s / V = density\ of\ the\ neutrons = n / V =$ the inverse of the

infinitesimal volume [6], and we have (on the same way of mathematics of Fermi sphere) the quantum energy density (which appears here in our model as Pauli's term because n is very much more than p)

$$u_c = \frac{\hbar^2}{2m}\left(\frac{3\pi^2}{V}n\right)^{2/3} \qquad (31)$$

This -for all neutrons- becomes

$$\int_0^n u_c\, dn = \frac{\hbar^2}{2m}\left(\frac{3\pi^2}{V}\right)^{2/3}\int_0^n n^{2/3}dn = \left[\left(\frac{3}{5}\right)u_c n\right]$$

Where n is the quantity of the neutrons of the giant proton unit, while V is its volume. And finally divide over n to get the average $< u_c> = (3/5)\, u_c$

By putting $r_c \approx 3.135 \times\times 10^{-16}\, m$ and by substitution in the above equation, we can estimate the average; $< u_c >= 0.748 \times 10^{-10} j \approx \frac{1}{2}m_o c^2$

This is a comfortable result, but since the accurate value of $\frac{1}{2}m_o c^2 = 0.752 \times 10^{-10} j$ and since our search in this point is not to define $< u_c>$ at $r_c = 3.135 \times 10^{-16} m$ but is to define the required spacing at $\frac{1}{2}m_o c^2 = 0.752 \times 10^{-10} j$ therefore by substitution of $\frac{1}{2}m_o c^2 = 0.752 \times 10^{-10} j$ in (31) and $r_c = 3.127 \times 10^{-16} m$ we can get

$$< u_c >= 0.752 \times 10^{-10} j \equiv \frac{1}{2}m_o c^2 \qquad (32)$$

2- The above is the <u>accurate spacing</u> which defines the Compton's sphere (as defined by equation 10). You can notice that the major character of this sphere is that the in-between distances are in the range of the reduced Compton's wave length r_c so you can take a Fermi sphere and put inside it the density as $r = r_c = 3.127 \times 10^{-16} m$ and then divide each r_c *over* γ (or over $\sqrt{c_o}$) and multiply each m with the same factor. Let us do, under the initial conditions and by the same rules of the proton potential well.

The relativistic gravitational energy $u_G(v)$ **-as speed function-** would be affected by the speed v more than the quantum term field $u_c(v)$ such that the factor c_o would appear in $u_G(v)$ with power $3/2$ while it appears in $u_c(v)$ only with power $1/2$

If we write $V = n\frac{4\pi}{3}r_o^3$ and if we put the factor A instead of the result of multiplication of the constant numerical factors $(\hbar^2/2\,(3\pi^2 \div \frac{4\pi}{3})^{2/3}$ in equation 31 then we can rewrite (31)

$$\therefore u_c = A\frac{c_o}{(m_o\, c_o^{1/2})r_o^2} = \frac{A}{r_o^2 m_o}c_o^{1/2} \qquad (33)$$

The factor $c_o^{1/2}$ arises from the relativistic mass in the dominator, while the factor c_o arises from the relativistic squared length $(r^3)^{2/3}$. The relativistic gravitational rest energy –as in the previous sections appears as

$$u_G = -G n^{2/3} m_o^2 c_o \frac{c_o^{1/2}}{r_o} \tag{34}$$

Where, A & G *are constants and* r_o -here- in this relativistic relation means the inter-particles distance r_c in a rest state (otherwise it means the classic radius of the neutron).

Putting $m_o^2 = -m^2$ (please recall in your mind equations 14 – 27) in equation 34, and then Equating u_c and u_G with simplifying c_o in both sides (as we did in the above section) we get

$$\frac{A}{r_o^2 m_o} = \frac{3}{5}\frac{Gm^2(nc_o)}{n^{1/3}r_o} \tag{35}$$

Putting $n^{1/3}r_o = r_s$ = radius of the sphere, we find u_G of (34) looks as (22) so we can get

$$\frac{A}{r_o^2 m_o} = u_G = \frac{3}{5}\frac{Gm^2(nc_o)}{r_s} \equiv \frac{1}{2}m_o c^2 \tag{36}$$

Adding the two energies of (36) we get

$$u = u_c + u_G = \frac{1}{2}m_o c^2 + \frac{1}{2}m_o c^2 = m_o c^2 = mc^2 \tag{37}$$

Where; u_c & u_G appears as conjugate pair which when be added together then added to the inertial rest energy they realize the state $v^2 = 2c^2$ as a relativistic solution for; $m_o^2 = -m^2$ where the negative sign gives the same radical physical meaning (again, the microstates should be chosen to realize the rest macro-state). Here you may notice that we have two frame levels. The proper one in which we see the microscopic events as relativistic m and r obeying the proper rules of the special relativity. The second is the alternative one in which the kinetic energy appears as reproductive energy and consequently, the relativistic mass m appears as m_o while r appears as r_o. All the above equations

The alternative solution is constrained by; inter-between distance $\approx 3.127\times10^{-16}$m. This gives (in the original solution) quantum kinetic energy for each neutron $\approx 0.752\times10^{-10}$ joule which when is added symmetrically to its conjugate gives the state of (37). The neutron (like the proton) appears in its potential (or precisely, the inertial) well as a pair of conjugate. We also notice -from equation1- that, $m = m_o \rightarrow r = r_o$

7- The integral form of Compton sphere:

The average of the quantum term as estimated before appears as;

By substitution and putting the value of r_c we can estimate the average;

$$< u_c > = 0.752 \times 10^{-10} j \equiv \frac{1}{2} mc^2 \tag{38}$$

But the average of the electric potential energy needs to do the following;

$$u = ke^2 \int_0^p \frac{p_{(r)}\, dp}{r}$$

$$p_{(r)} = p \left(\frac{r}{R}\right)^3 \quad \& \quad dp = 3p \frac{r^2}{R^3} dr \quad \rightarrow \int_0^p \frac{p\, dp}{r} = 3p^2 \int_0^R \frac{r^5}{rR^6} dr \quad = \frac{3}{5} p^2 \frac{R^5}{R^6}$$

$$= \frac{3}{5} \left(\frac{p^2}{R}\right) \rightarrow u = \frac{3}{5} k \frac{e^2 p^2}{R} \tag{39}$$

We can do the same manipulation with the average gravitational energy. So the average gravitational and electric energy appears as

$$\frac{3}{5} G c_o \frac{m_o^2 n^{2/3}}{r_c} =< u_G >=< u_e >= \frac{3}{5}\left(\frac{1}{2} m_o c^2\right) \tag{40}$$

This form is not compatible with the inertial form $\frac{1}{2} m_o c^2$ so we can modify the form of the equations to appear as

$$\frac{3}{5}\left(\frac{r_o}{r_c} \frac{p^{\frac{2}{3}}}{\left(\frac{n}{p}\right)^{\frac{1}{3}}}\right) = \frac{1}{2} \tag{41}$$

Where, the question is to find the quantity of the protons p, which realizes this modified integral form. And to appear as

$$\frac{3}{5} G c_o \frac{m_o^2 n^{2/3}}{r_c} = \left(\frac{1}{2} m_o c^2\right) \tag{42}$$

Where, the question is to find n which realizes this modified integral form.

But we do not have –from the system- enough equations to define all the unknowns of the system. Let us search.

8- Definition of the giant proton unit & driving its unknowns:

From the definition of μ and from equation 29

$$\mu = c_o \frac{n}{p} = \frac{c_o n}{p} = \frac{N}{p}$$

Where N is the quantity of the neutrons in the giant (relativistic) proton while n & p is the quantity of neutrons & protons in the giant charge unit.

We want to define c_o as a universal constant. In the second part of the discussion we will estimate$N$

$$N = 3.009 \times 10^{45}\ neutrons \tag{43}$$

By dividing each side of equation 22 over c_o we can define

$$\frac{1}{2}mc^2 \frac{n}{p.\mu} = \frac{1}{2}mc^2 c_o = {}^{u_G}/_{c_o} = u_g = \xi \tag{44}$$

And from the meaning of self-replication of the giant proton unit -till it reaches to the giant proton- and recalling equation 30

$$N/n = P/p = c_o \tag{45}$$

$$\therefore N = n\, c_o = (\frac{n}{p}p)c_o \tag{46}$$

$$\text{And since } \frac{1}{2}mc^2 = u_g c_o \tag{47}$$

$$\text{And since } u_g = \frac{3}{5}G\frac{m_o^2 n^{2/3}}{r_c} \tag{48}$$

From (22, 24 and 48)

$$\frac{1}{2}mc^2 = u_G = \frac{3}{5}Gc_o \frac{m_o^2 n^{2/3}}{r_c} = u_e = \frac{3}{5}ke^2 \frac{p}{r_c n^{\frac{1}{3}}} \tag{49}$$

By dividing u_G of (49) over (46) -where c_o is cancelled- we can get the value of n

By putting the value of n and substitution in (46) we can define c_o and then from (49) we can define p (from u_e)

From defining p & n we can define the ratio $\frac{n}{p}$

From the defined values of $\frac{n}{p}$ & c_o we can estimate μ from; $\mu = c_o\,(\frac{n}{p})$

At last from (39) we can –also- define- u_g

This arrangement in derivation of the unknowns (where we derive u_g after solving the entire unknowns) is necessary (we will explain this latter). Now we can estimate all the unknowns as

$$p = 2.431 \times 10^9 \tag{50}$$

$$\frac{n}{p} = 1.2123 \times 10^{12} \tag{51}$$

$$n = 2.947 \times 10^{21} \tag{52}$$

$$c_o = 10^{24} \times 1.021 \tag{53}$$

$$\mu = 1.237 \times 10^{36}$$

$$v^2 = c^2\left(1 - \frac{1}{10^{24} \times 1.021}\right) \tag{54}$$

It is clear –now- that we cannot realize equation 2 with speed less than that defined by equation 54. A lesser one cannot realize equation 6. It is the familiar to equate the particle speed by real number: $v = 0, \frac{1}{2}, 10$ *and so on* but here, physics of the alternative relativistic solution allows equating the squared speed as *c minus an* infinitesimal *cut off*. This cut should not allow a lesser squared speed than that of equation 54. But a bigger one (approaching more to the speed of light) is allowed. This allows –from equations 23 and 56- a bigger γ^2 (c_o) which means replication of a bigger sphere (this is the scientific base for a more complicated giant atom as we will see later). Therefore, we can define c_o to include more complicated giant system:

$$c_o \in \mathbf{R} : \infty > c_o \geq 10^{24} \times 1.021$$

We have to notice that the protons have the same wavy behavior and so it has –also- u_c but this term could be neglected because of the distance between two neighbor protons = 10^4 r_c (where n / p as we will see is about ten power twelve). So, the exclusive Pauli's term of the proton well appears as; $u_u = 10^{-8}u_c = 10^{-8}u_e$ so the final count of the protons - which realizes equation 1 in its coulomb form- is $p = 2.431 \times 10^9 - (10^{-8} \times 2.431 \times 10^9 = 2.431 \times 10^9$

Because we estimated the above values from outside the system of the giant unit (using, N) so we have to test them. So putting the above values in the equations of the system we find finally:

$$u_G = u_e = u_c = 0.752 \times 10^{-10} j = \frac{1}{2}mc^2 \tag{55}$$

9- The deficit & the excess as a perfect solution:

The goal here is to show how the term b is delivered from the same alternative relativistic solution which was fired by the starting point (equation 7). If this term was found independent from the alternative solution and since the deficit equal the excess then both with each other had to give zero term. The zero term would spoil the deficit and consequently aborts the relativistic action. The relativistic action needs a deficit (not zero term). Then, it looks as if the excess was delivered side by side with the term D and by the same alternative relativistic solution. That is to say; equation 7 is actually the launching point. First, we can summarize what we got.

We **'picked up'** the imaginary relativistic solution, $m = i\,m_o$ where $i = \sqrt{-1}$ and then converted this imaginary solution into refused solution in the form of $m^2 = -m_o^2$

After that, we introduced this refused solution on the relativistic gravitational energy, and then go on till we reached to the accepted substitutive relativistic solution. So physics of the giant charge could be summarized as a shift from the original solution; $(\gamma^2 m_o^2)\,n$, into the substitutive (self-replication) solution; $[c_o\,(n+p)]\,m_0^2$.

The alternative solution is surely not passive transformation of energy into matter (not as; $m = \frac{E}{c^2}$) but surely it is relativistic solution. The passive transformation would give one particle for each of the contributors.

The relativistic solution is completely far from this vision. It could be written as

$$m^2 n = m_o^2(\gamma^2 n_o) \tag{56}$$

In the original solution $n = n_o$ while in the alternative solution $m = m_o \rightarrow n = c_o n_o$

The first point to motivate physics of the Compton's sphere is to insure that the total Compton state final energy u, per a particle neither above nor below $m_o c^2$. Its net value should be exactly $m_o c^2$. If it was above this limit then this means that $v > c$ which is -in relativity- refused. We need to reach to the highest possible speed because equation 1 is the subject & key of the Compton's sphere. But if the particles spacing was equal r_c and consequently, the acquired quantum energy $u_c \equiv \frac{1}{2} m_o c^2$ then when it is added with the acquired nonrelativistic gravitational energy u_g it would give total acquired energy above $\frac{1}{2} m_o c^2$ or mathematically, $u > 0.752 \times 10^{-10} j$ which is refused. Hence, we can write;

$$u_c = u_e = u_G = \frac{1}{2}(m_o c^2 + u_g) = \in \tag{57}$$

Since, $m = m_o$ (if equation 27 was realized) then we can describe the particle represented by equation 2 and also represented by equation (9) as

$$E = E_o = m_o c^2 = mc^2 = (m_o c^2 - u_g) + u_g \tag{58}$$

Where, u_g -with the small letter subscript- is a negative quantity stands for the nonrelativistic gravitational energy ($not\ u_G$). Equation 58 surely describes (1 & 2) but –till up now it cannot describe our sphere without realization the condition mentioned in (9 & 27) which are not yet realized. Equation 57 is just to say that: to prevent excess speed over c or to prevent the state which is inside the brackets of (58) we have to add $+u_g$ or definitely the acquired energy must be not over the energy of (57). But this equation alone doesn't tell us how does u_g precipitate in the system. All the equations which contain a cutoff energy could be understood on this base. In equation 7 -as example- the deficit $\equiv\ u_g$ so when the system adds u_g as in (6) we guarantee that no excess speed over light. Definitely it says; if $m_o c^2$ represents acquired energy then it is forbidden to add to it any infinitesimal energy so the contents of the above brackets in (58) is forbidden and hence the energy should appear as in (57).

You can have a population of neutral particles with zero electric energy. And you can have a population of particles with zero short range energy if the in-between distance was far from Fermi range. And you may get a population of matter with zero quantum energy such that Pauli's Exclusion Principle may disappear in condensate state (like; Cooper's pair & neutron pair). Moreover the quantum term which appears in equation 33 depends reversibly on the mass so it disappears at the mass goes to infinite. Definitely, you can forever multiply a wave function -describing a quantum particle- by a non-zero complex constant A, to get –by linear combination- the same state with the same physical concept as

$\psi\,(x)\ =\ A\,\varphi(x)$. That is to say, linear space itself is a subset of Hilbert space which means that the exclusive efficiency vanishes at linear combination.

But you never get matter without gravitational energy. On general: no field is forever synonym to matter except the gravitational field. Since each of the contributors; u_e, $u_c\ and\ u_G$ are rest energies and would be added to the particle and since the gravitational field never vanish from matter and since the system supplies each particle with u_g then the contributors should have a deficit equal u_g otherwise the added u_g of the system would add speed to light which is forbidden. This additive u_g is the residual energy of the system after withdrawing all the other energies.

Since, $(m_o c^2 + \xi) - u_g = m_o c^2$

$\therefore\ \xi\ =\ u_g$ If -and only if- the system equations precipitate u_g

We began with equation (7) and followed up the microstates of the coulomb's form where each conjugate pair realized in the approximate solution that the relativistic mass is equal to the rest mass, so up till now we are still maintaining the general structure of (1 & 2) if –and only if- (9 & 27) were realized (or if the term b was deposited). Equation 58 expected presence of u_g but it did not precipitate it. So we need to fix (57) on equation 58 (but without its brackets). Let us see how. Now, since $v\ \approx\ c$

And since, $v^2 = c^2 - {c^2}/{c_o} = c^2 - c^2\frac{n}{px\mu}$

Then the conjugate pair u appears as;

$$u = u_e + u_G \equiv (m_o c^2 + u_g) \tag{59}$$

Again, since $v \approx c$ then, one can say that the relativistic solution $v^2 = 2c^2$ should also take the form

$$v^2 \approx 2c^2 \rightarrow v^2 = 2c^2 - 2\left(c^2\frac{n}{p\mu}\right) = 2c^2 - 2\left(c^2\frac{1}{c_o}\right) \tag{60}$$

Actually this speed (as we will discuss later on) doesn't need external source of energy outside the system. If we looked to the neutron in its well and if $r_c = r$ then it would appear as energy not as matter. But because the inter-space here is just above this limit so -from de Broglie wave- we get oscillatory motion defined by (10). Also the proton does in its well. This is a description of the microstate events. If we took the equations (20, 24 &37) we find them describe the macro state of a system perfectly fixed on (1). That is to say: if equation 1 describes the rest mass $m = m_o$ of the rest particle then its synonym (equation 2) describes the rest energy $E = E_o$ of the Compton's sphere per each rest particle. This means that if (1) succeeded to arrest its left side to describe -in its right side- the rest mass then also does equation 2 where it succeeded to arrest its left side to describe –in its right side- the rest energy (of the Compton's sphere per a rest particle). Hence, a deficit (or excess) in (2) should mean necessarily the same deficit (or excess) in (1) and vice versa.

This idea should be maintained and never waste. Explicitly, the energy which we observe in a conjugate pair of u is not more than description of the rest energy of the Compton's sphere per rest particle perfectly as equation 1 describes the rest mass.

. Equation 58 describes the rest energy of the particle of eq.1 perfectly. And it can also describe the particle of our sphere but only when we do approximation for the relation $v^2 \approx 2c^2$ to appear as $v^2 = 2c^2$

The approximate solution enabled us to fix our system on the form of (1), where (58) described the rest energy as a perfect synonym to the rest mass.

Now we can begin again from the speed which is defined in (10), so let us recall the accurate value of v^2 as it is defined in (60) and put it in its original relativistic relation

$$\therefore m^2 = \frac{m_o^2}{1-(2-2\frac{1}{c_o})}$$

$$\therefore -m^2\left(1 - \frac{2}{c_o}\right) = m_o^2 \tag{61}$$

As in the approximate solution, we can put here m_o^2 in place of $-m^2$ (again, the micro-states should be directed to realize the macro-state, meaning that we are searching ,here, for the condition required for the microstate; $v \approx c$ to realize the macro-state;$v^2 \approx 2c^2$)

$$\therefore m_o^2\left(1-\frac{2}{c_o}\right) = m_o^2$$

This is the same radical physical meaning of the proposal of (20) where here it again engulfs the negative sign of the equation in which it was introduced to leave behind a physical meaning. The equation -now- tells us that we have one particle with two different rest masses. The unique solution should be defined by different systems. That is to say the right side of the equation represents the rest mass of the particle (m_s) inside the sphere before adding u_g while the left side represents (m_o) outside the sphere or inside the sphere after adding u_g

$$\therefore m_o^2\left(1-\frac{2}{c_o}\right) = m_s^2 \qquad (62)$$

$$\therefore m_o\sqrt{1-\frac{2}{c_o}} = m_s \text{ Using the binomial theorem}$$

$$\therefore m_o(1-\frac{1}{c_o}) = m_s$$

$$\therefore m_o - \frac{m_o}{c_o} = m_s \qquad (63)$$

By simple simplification and multiplying each side by c^2 and then substitution from (44) with the value of u_g and substitution in (63)

$$\therefore m_o - \frac{m_o}{c_o} = m_s \rightarrow m_o c^2 - \frac{m_o c^2}{c_o} = m_s c^2 \rightarrow m_s c^2 - u_g = m_o c^2 \qquad (64)$$

This is the relativistic solution for existence the nonrelativistic u_g in our system. Hence, we can fix (57) on (58) as; $E = E_o = m_o c^2 = mc^2 = (m_o c^2 + u_g) - u_g$

Where the contents between the brackets represent the equivalent energy of the rest mass of the particle inside the sphere (the particle with the deficit) while the positive u_g is the added gravitational energy so the relativistic mass $mc^2 = m_o c^2$

Also the energy $u_c = u_e = u_G \equiv \frac{1}{2}(m_o c^2 + u_g) = \in$ is defined –now- by;

$$(m_o c^2 + u_g) - u_g = m_o c^2 \qquad (65)$$

$$2 \in - u_g \equiv m_o c^2$$

If we put; $m_s = 2\ni$ & the deficit in each of the mass & energy respectively as m_d & m_f

$$\therefore \in = \ni, m_d = \frac{m_o}{c_o} \equiv \frac{m_f}{c^2} \equiv \frac{u_g}{c^2}, \quad m_f = u_g, m = m_o = m_s + m_d \qquad (66)$$

$\therefore\ m_o = \varphi(u_g)$, therefor it is the relativistic mass of m_s

We notice also in the approximate solution that, we used $m = m_o$ which gave approximate solution in the form of equation 27. Here –in the perfect solution- we can discriminate between m_o & m_s where the perfect solution appears as in (60). We can clarify the entire physical meaning of all the equations from (22) till (66) as the next;

Since the deficit in the rest mass of the particle which is defined by equation 1 is a deficit in the rest energy of the Compton sphere (per a particle) which is defined by equation 2, so we began from;

$$\tfrac{1}{2}\left(k\tfrac{e^2}{r_o} + u_g\right) = \tfrac{1}{2}m_s c^2$$

This deficit fired up the relativistic solution by the speed which is defined by (10). Then we used the original relativistic technical tools which finally produced the alternative relativistic solution which appeared as: $n = \gamma^2 n_o$ where γ is defined by the speed which is defined by (10). Beside this relativistic solution we discovered another relativistic solution represented in that: this speed which is defined by (10) does not affect the mass, so the solution was: $m = m_o$ but this solution ($m = m_o$) is defined by a condition defined by (27) which needs adding an excess quantity equals the deficit quantity. We called that solution "the approximate solution" which did not show how such quantity was added. The perfect solution is the complementary solution which explained this point. Since that, then it has to use the same relativistic technical tools but with the correct speed defined by equation10. Then we have to allow the proposal defined by (20) to interact mathematically with this correct speed to see the relativistic condition required for producing this excess. The perfect solution discovered that; the alternative relativistic solution is the one which added excess mass and consequently excess energy equal the deficit. So, we can summarize as

$$\left(\tfrac{1}{2}G\tfrac{m_s^2}{r_s}\right)nc_o + \tfrac{1}{2}G\tfrac{m_d^2}{r_s} = \left(\tfrac{1}{2}k\tfrac{e^2}{r_o} + \tfrac{1}{2}u_g\right) - \tfrac{1}{2}u_g = (\tfrac{1}{2}m_s c^2) + \tfrac{1}{2}m_d c^2 \qquad (67)$$

Where, the content between the brackets appears with its deficit which fired the alternative relativistic solution which delivered all the outside the brackets. Finally we get; $\tfrac{1}{2}Gm_o^2(nc_o)\ /\ r_s = \tfrac{1}{2}\left(k\tfrac{e^2}{r_o} + u_g - u_g\right) \equiv \tfrac{1}{2}m_0 c^2$

And by the symmetric addition we get: $\tfrac{1}{2}m_0c^2 + \tfrac{1}{2}m_0c^2 = m_0c^2 = mc^2$

The last equality was put to show that we are finally in a complete rest state ($m = m_o$). When the mass m_d is added to $m_s \rightarrow m_o$ therefor we can consider m_o is the relativistic mass of m_s where **this relativistic effect** is due to the speed coming from u_g not from the speed defined by (10)

Defining the unknowns of the Compton sphere depended on the next idea; since we began from $\tfrac{1}{2}\left(k\tfrac{e^2}{r_o} + u_g\right) = \tfrac{1}{2}m_s c^2$ and since, $m_s \approx m_o$ *while* $u_g \ll k\tfrac{e^2}{r_o}$

So, the approximate solution ignored the small deference between these quantities where the equation got; $\frac{1}{2}k\frac{e^2}{r_o} = \frac{1}{2}m_o c^2$

This inconsiderable error which was committed by the approximate solution could not be avoided because each of m_s & u_g is unknown (but could be derived after defining the other unknowns)

$$\therefore m_s = m_0 - m_d = m_o - \frac{m_o}{c_o} = m_o\left(1 - \frac{1}{c_o}\right) = m_o(1 - 10^{-24}) \approx m_o$$

This means that from the quantitative side of view we can put $m_s = m_o$ and we can do our estimations on this base. Nevertheless, from the qualitative side of view the deference between both is the scientific base of physics of the giant atom so we cannot neglect the physical concept of this deference. Although the perfect solution is the one which discovered the term carrying the excess quantity which we were searching for in the approximate solution yet the approximate solution is –also- necessary and we cannot exclude it because it supplies us with the easy or perhaps the unique mathematic method to derive the unknowns of the giant charge unit. If you put m_s of the perfect solution in place of the approximate solution you cannot simply derive the unknowns, while -as you saw- it was easy to do in the approximate solution (equations 45 - 54). Minimizing the incorrectness (arising from the difference between m_o& m_s) -during estimating the Compton sphere unknowns- depends on important idea. Since we expect that m_s & $u_g \ll 1$ while each of the countable unknowns $\gg 1$ so we avoided to derive the unknowns from this little quantity, so we derived at first $N > 10^{45}$ from u_g of the giant atom (which is comparatively big quantity) not from u_g of Compton sphere and then we derived $n > 10^{21}$ from u_G not from u_g and so on all the unknowns were derived independent from u_g By other words, since u_g is the smallest so the error factor arising from the difference between m_o& m_s would be clear in it, so to avoid this effect on the other unknowns we do not derive them from u_g

Anyway, equation 79 from which we will derive the quantity N shows that the speed resulting from the gravitational energy is so little that we can neglect m_d

The meaning of m_o & m_s appears well from the normalized wave function, where the wave number $k = \frac{2}{l} = \frac{m_s}{\hbar}c$.

Appearance of the rest mass as m_s in the subsection (13-a) is well perfect because $\{c^2 + \varphi(u_g)\} - \varphi(u_g) = v^2 - \varphi(u_g) = c^2$ where the contents of the outer brackets gave the relativistic alternative solution defined by equation 28 while the negative $\varphi(u_g)$ would transform –by its relativistic action- m_s into m_o. But 13-b, does not give the meaning of split of c^2 because it talks about the rest state. Hence, the physics of (13-b) needs the particle to appear as m_o

We can summarize all the above chapters to give the global picture as follows;

Given a particle let be called P, defined by $k\frac{e^2}{r_o} = m_o c^2$ (see appendix) where this equation says; the rest mass is equivalent to the rest energy. The particle in the giant charge committee is defined by rest mass m_s & mass deficit m_d but since the rest mass of this equation is synonym to the rest energy of equation 2 which describes the macroscopic state of our sphere so this mass deficit appears also as rest energy deficit. Hence the particle appears as

$k\frac{e^2}{r_o} - m_d c^2 = m_o c^2 - m_d c^2 \equiv 2 \in$ This deficit in energy fired out the alternative relativistic solution defined by (56). But the particle with this deficit is not the particle P. Fortunately, The relativistic solution itself is the one which delivered energy excess equal the energy deficit. And again, since the rest energy of the sphere per a particle (defined by equation 2) and the rest mass (defined by equation 1) are synonyms so we have the same excess in the mass too. Hence the particle appears as

$(k\frac{e^2}{r_o} - m_d c^2) + m_d c^2 = (m_o c^2 - m_d c^2) + m_d c^2$ This is the particle P, and the net result is γ^2 times the particles count in the sphere. The perfect solution is the one which produces the alternative relativistic solution while the approximate solution is the one which enables us to determine the unknowns of the Compton sphere. Presence of u_G in the system beside u_g is not contradictive because the first when added with its conjugate has final relativistic meaning not more than (as you see that from the equations) $m = m_o$ while the second carries the effect of the gravitational energy. So, we can say that, the first (the relativistic one) carries with its conjugate the meaning of the rest energy of the system per a particle $E_o = m_o c^2$ *while the second carries the meaning;* $\frac{1}{2}mv^2$

As in the **semi-empirical mass model** the nucleons inside the nucleus has mass deficit which appears as nuclear binding energy also here. The particle inside the Compton sphere has to pay from its pocket to subscribe as a member in this committee. The sphere looks like a giant particle where its vacuum is absolutely energy empty so the particles to live with each other they have to pay from their masses. We have also do **stress** on that, the system itself by its nonrelativistic equations cannot precipitate u_g because each of Einstein & coulomb form talks nothing about it although coulomb's form (the microstates) expected its existence. The matter also calls it, but the allowed nonrelativistic equations cannot realize it. So the relativistic equations discovered the trivial solution;

$$u_g - u_g = 0 \qquad (68)$$

But its hidden nontrivial meaning is that; each of the minus & the positive u_g & its synonym m_d is a relativistic solution. The deficit in the rest mass of equation 1 is equivalent to the deficit in the rest energy of equation 2 but this deficit by the relativistic action have created final relativistic solution formed of one packet appeared as; reproduction of particles counting $(n + p)c_o$ each with final rest mass $= m_o$ where the entire particles are living in Compton

sphere each with mass deficit and with residual gravitational energy. So, u_g of the system, although it is non-relativistic entity yet it is one of the products of the alternative relativistic solution.

The kinetic energy appears -by the alternative relativistic solution- in a rest form. This means that the GCU have appeared after all these relativistic micro-states to realize equations1 where it means actually that it came from multiplication of equation1 by the number one to give the same solution. The energy looks as if it was turned from the region of the kinetic energy and flashed in the region of the reproductive rest energy with the simple conservative momentum & energy solution;

$\mathbf{P} = \mathbf{P}_1 + \mathbf{P}_2 = 0$

$E = 2\int pdv = m2c^2 \quad Where\ v\ =\ c = constant$

In biology, self-replication takes other form. The chromosome of the cell of the living thing – by metabolism- utilizes the nutrients to construct another chromosome. No creation of particles; neither from energy nor from relativistic action. Number of the input of the particles (of the mother chromosome + of the utilized nutrients) is the same of the output (of the mother chromosome + of the born one). The cell during replication does not gain particles. So the substitutive solution is not clearly suitable here. The dead or even the adult, or accurately the immature or even the old cell cannot replicate even if it was put in a bath of the required nutrients or –accurately- even if it was put in the same biologic medium required for replication. Here, there is no mass deficit and consequently no energy deficit. The chromosome acts as a template and appears like $\ni = m_o c^2$ but without deficit, while the particle of the nutrient appears like $\in = m_o c^2$ (but without deficit). When they added $\rightarrow$ $m_o 2c^2 = 2m_o c^2$

10- The wave function & the concept of the particle speed:

The defined density of matter -inside our sphere- alone can offer quantum speed for the neutron, but it cannot alone define the proton speed which needs defined number of protons with the same defined density. We saw that speed of both particles is defined by equation10, but what is the concept of this speed? The energy eigenfunction of the particle inside the potential wells could be written as;

$\varphi = A\sin kx = A\sin n\pi x/L = A\sin x\left(\sqrt{2mE}\right)/\hbar$ Where on normalization; $A = \sqrt{\frac{2}{L}}$

Since, the momentum operator $\check{p} = -i\hbar\,\partial/\partial x$

And since, $\partial\varphi/\partial x = \left(\sqrt{2}/L\right)n\pi/L\cos n\pi x/L$

$\therefore < p >= \int_0^L \varphi^* \check{p}\varphi\, dx = \left(i\hbar/_L\right)sin^2 nL\pi/L = 0$

At first glance this conclusion seems strange. After all;

$E = p^2/2m \rightarrow p = \sqrt{2mE}n = \pm n\,\pi\hbar/L$ The ± sign provides the explanation: The particle is moving back and forth, and so there should be two momentum eigenfunctions for every energy eigenfunction, corresponding to the two possible directions of motion. The procedure for finding the eigenvalues of a quantum -mechanical operator $\hat{p}$ is to put the correct momentum eigenfunction as;

$sin\,\theta = \frac{e^{i\theta}}{2i} - \frac{e^{-i\theta}}{2i}$ Hence each energy eigenfunction can be expressed as a linear combination of the two wave functions so that $\varphi = A\,sin\,n\pi x/L = \varphi^+ + \varphi^-$

$\varphi^+ = A\,sin\,n\pi x/L = A\,\frac{e^{i\theta}}{2i} \rightarrow p^+ = n\,\pi\hbar/L.$

$\varphi^- = A\,sin\,n\pi x/L = A\,\frac{e^{-i\theta}}{2i} \rightarrow p^- = -n\,\pi\hbar/L.$

From above we conclude that the particle inside the Compton's sphere oscillates back and forth with its speed $v \approx c$.

From the side of view of special relativity, (if the capital letters stand for the measurements on the moving coordinate) we hold on the synchronous measurement (T= 0) for a body moving to the right:

$x_o = (X + vT)/\gamma = X/\gamma$

And for a body moving to the left we would hold:

$x_o = (X - vT)/\gamma = X/\gamma$ this means that Lorentz length contraction holds with the same form either the body moves back or forth such that γ factor depends on the squared speed of γ so $v^2 = (-v)^2$ You can notice that our case differs from Doppler effect, such that we want – here- to measure x relative to x_o and $-x$ relative to $-x_o$

Since -as we have discussed before- both x_o & m_o go straight forward in a linear relation so the same result holds with the relativistic mass.

Actually many experimental trials succeeded to trap ultra-cold neutrons in slow speed. High technology succeeded to trap neutrons with speed of 5 meter per second [7, 8]. If we could to get the least possible speed like that of the giant charge then we may get it. But I can suggest that if we had a universe defined by the equations 45 - 54 or if we had count of neutrons defined by (52) each with speed $v = \sqrt{\frac{2u_g}{m}}$ or may be defined by equation 10 then the particles may spontaneously condensate to Compton state.

11- The solar system as giant atoms:

Now in this second part of the discussion we would suggest that the solar system in one of its primordial historical evolutionary stage had presented as giant atoms. This suggestion would be tested by doing comparison between our estimations about the parameters of the orbits of the giant atom and that of the solar system.

The tested parameters of the solar system would be the speed and radius of the orbit of each planet, the elliptical orbits of the planets and also we would define the ratio between the mass of the sun to the total mass of the entire planets. So, our work suggested that the solar system had begun its motion as units of giant atoms. Later on, the atomic model disappeared after it

left behind the above mentioned parameters to refer to the past existence of the giant atomic model.

Now the giant atom was formed of giant charges, and the giant charge had existence in the form of Compton state. Existence of such state -as we saw from physics of the giant atom- has overcome the following problems; coulomb's force which would not allow existence of much charges in a comparative narrow space like the giant charge, Pauli's exclusion principle; which never allow two typical fermions to exist in the same energy level and the quantum energy density which acts against condensation of matter in such a state. We would see also (after estimating the radius of the giant atom orbit) that the giant charge can orbit as a collection of points in a circle without considerable radiation (not violating Larmor's equation).

11-1- The hydrogen atom like system [10, 11]:

Consider an electron e, with a non-relativistic mass m_e and a proton p, with mass m_p orbit each other and consider μ stand –here- for the reduced mass.

The two body problem could be reduced as one body problem as

$$\mu = m_e m_p \div (m_e + m_p) \;\&\; m = m_e + m_p$$

If, $m_p \gg m_e$

$$\therefore F = m_e a = \mu a \quad where, a = a_e - a_p$$

If, $r = r_e - r_p$

$$\therefore ke^2 \div r = m_e (v_e)^2 \div r_e = m_p (v_p)^2 \div r_p$$

The Lagrangian Lg could be written as;

$$Lg = [m_e (v_e)^2 \div 2] + [m_p (v_p)^2 \div 2] - U(r_e - r_p)$$

The modulus of the angular momentum vector = L

$$L = m_e v_e r_e + m_p v_p r_p \approx m_e v_e r_e = \hbar$$

$$r_e = r m_p \div m \approx r \qquad (69)$$

$r_p = r\, m_e \div m$

The ground state could be described by the Hamiltonian H in time dependent form

$$H = -(\hbar^2 \div 2m)\, \partial^2 / \partial x^2 + (E - U) = i\hbar\, \partial / \partial t$$

The solution gives;

The expected radius $< r > = 5.29 \times 10^{-11} m$

The expected velocity $< v > = 2.18 \times 10^6 m / s$

11-2- The major atom; a proposed inversed atom:

Although it is a proposed system yet it is the mathematic base of the giant atom system. In the giant electron we can hold the same equations of the giant proton.

Since, the proton count p in the giant proton = the electron count e in the giant electron and since the electron mass $m_e = \frac{1}{1844} m_p$ where m_p is the mass of the proton and if we substituted in equation16

$$\therefore \frac{n}{e} = 1844 \rightarrow \frac{M_e}{M_p} = 1844$$

Where, $\frac{n}{e}$ = the ratio between the neutrons & the electrons in the giant electron, while $\frac{M_e}{M_p}$ = the ratio between the mass of the giant electron & the giant proton. Hence we can say that the giant atom is a perfect inversed atom. This chapter is to study the mathematics of this inversed atomic system. So, in the hydrogen atom like- system (h.a.l.s); suppose that we succeeded to bind its electron through imaginary energy with a number of neutrons = $\frac{m_p}{m_e} = 1844$ neutrons. And suppose that this proposed binding energy ≥ the total energy between the proton and its orbiting electron such that the neutrons bound electron can orbit as one body. Once we can create this imaginary major atom we will notice that here would be shift of the center of the masses towards the neutron bound electron. There would be (also) respective relative shift from quantum to classic physics. Let us study this inversed atom (i.a.) side by side with (h.a.l.s.) and let us use for the first the capital letters and for the second the small letters.

We did nothing except binding the electron with 1844 neutrons so;

$$ke^2 \div r = ke^2 \div R \rightarrow R = r$$

From (69)

$$\therefore \boldsymbol{R}_p = M_e \boldsymbol{R} \div \mu \approx M_e \boldsymbol{R} \div M_e = \boldsymbol{R}$$

$$\boldsymbol{R}_e \approx M_p \boldsymbol{R} \div Me \approx \boldsymbol{R} \div 1844$$

Where, M_e is mass of the electron which is bound with 1844 neutrons

$= 1840\ (M_n \div M_p)\ M_p = 1844$ as much as the mass of the proton.

And where, μ = the inverse of $\frac{1}{M_p} + \frac{1}{M_e} = M_e \div 1845 = M_p \div 1.0005 \approx M_p \rightarrow R = R_p = r\ \&\ v = v_p$

From above we can get

$ke^2 \div r = ke^2 \div R = M_p v^2$

The angular momentum L obeys; $L = L_p + L_e = l\,\hbar$

Where, l is an acquired inversed atom level number.

On substitution we get

$$v = 2.18 \times 10^6 \sqrt{(m_e \div m_p)} = 2.18 \times 10^6 \div 43 \approx 5.07 \times 10^4\, m\ /\ s \qquad (70)$$

$$l = 43 \qquad (71)$$

This speed is the speed of the orbiting proton in this theoretical inversed atom model. Since the giant atom is inversed atom model so it conserves the same speed.

We can get also

$\lambda_o = \lambda \div 43 \rightarrow 2\pi R = l\,\lambda_o = l\,\lambda \div 43 = \lambda$

Where λ is the wave length of Bohr's radius

11-3-The huge charge:

Here we have to focus on the next equations of the giant atom which supplies us with the physical unit of the orbiting giant charge; let us call it the huge charge. The huge charge which appears in the giant atom equations is the smallest unit of the orbiting charge. It has a mass m_u and a matter wave length λ_u

$m_u = m\,(n \div p)$

$$\lambda_u = \lambda \div (n \div p) \qquad (72)$$

Where λ is the wave length of Bohr's radius.

Its angular momentum would be in the form;

$(m\,n \div p)\,[(\lambda\,l \div l)\,(p \div n)]\,v = l\,\hbar$

The circumference S of the giant orbit is the summation of the huge waves;

$$S = 2\pi R = \left(\lambda \frac{p}{n}\right) p$$

The orbital could be considered as one dimensional infinite square well of length $2\pi r$ or a model for a one-dimensional box. Since that, we have two particles with different states; $+\,{}^1/_2\ spin$ & $-\,{}^1/_2\ spin$ occupying the same energy level. So that,

$$S = 2\pi R = \lambda \left(\frac{p}{n}\right) \frac{p}{2} = \frac{\lambda}{2} \left(\frac{p}{n}\right) p$$

You can –also- consider that the factor 2 in the denominator is due to that; the wave length is formulated as "a particle in a box model" such that; $2L = \lambda = bohr's\ wave\ length$

Since, "in this chapter" n & p is the number of neutrons & protons inside the giant proton (not inside the Compton sphere) & since, $(\frac{p}{n})$ is constant and is defined here in the giant proton as it was defined in the Compton sphere by equation 51, and since $p = (\frac{p}{n})n$

$$\therefore S = 2\pi R = \lambda\left(\frac{p}{n}\right)\left(\frac{p}{n}\right)\frac{n}{2} = \lambda(\frac{p}{n})^2\ \frac{n}{2} \qquad (73)$$

Notice: the factor inside the brackets is constant as defined by equation 51 (it is the same; in the relativistic Compton sphere & in the giant proton) while n is the number of the neutrons inside the relativistic giant proton (which we called in equation 43; N).

11-4- The mathematic analysis of the giant atom orbit:

The giant proton to orbit the giant electron we need equation in the form of;

$$G(\frac{m.n}{r})\ (\frac{n}{p}.m)\ \geq\ ke^2\ \frac{p}{2R} \qquad (74)$$

Where the left side of this relation means the gravitational energy inside the giant proton per a huge proton lying on the most outer layer of the sphere (defined by the mass $\frac{n}{p}.m$ and defined by the radius of the relativistic sphere) while the right side is the electric energy between the giant electron and the giant proton in its orbit defined by the orbit radius R per a huge charge. This form simply and directly means that:

Since the spheres are in orbits then the total energy equals half the electric potential energy. If this total attractive electric energy between the sphere A and a huge charge of the outermost layer of the sphere B was just equal or lesser than the gravitational energy which binds this huge charge with its sphere then the sphere would orbit as one body. Obviously, we take a charge from the most outer layer because according to Gaussian's theorem, although the most outer layer has the maximum flux yet its particles has the minimum gravitational potential so we guarantee that if this particle preserved on its sphere then all the particles of the sphere would do the same. If the left side of the above relation was lesser than the right side then the charges of the giant atom would be attracted as singled particles which would lead to evacuating it from the charges and consequently destroying of the whole electric building. This is very important point which would give radical and dramatic event would be discussed later (during talking about the end of Compton sphere). The hidden important meaning behind the factor $(\frac{n}{p}.m)$ is that we want to guarantee –under the above mentioned condition- that the huge proton is the unit of the orbit.

In one word this condition (the equality form) guarantees that the sphere would orbit as huge charges units with the least amount of n and consequently of p. But the relation in its inequality form can allow additional n as we will see when we speak about the astronomic giant proton. (Obviously, we can conclude the same required condition if we applied correctly the physical meaning of the escape velocity). Since, -as we will see- the higher orbitals are built by additive particles to the ground state so this ground state should be built by the least amount of the particles. So, equation 75 neglected a factor coming from the integration which had to be considered. Suppose that the total electric energy between the giant proton A, & the giant electron B, is just more than the total binding energy inside A, so that A, would be evacuated from its charges. We want to estimate the least amount of the charges which cannot do evacuation such that adding any other amount of the charge -even one charge- would lead to increase the electric potential more than the binding energy so evacuation begins to take place. Since that, we want to prevent addition of extra proton. Therefore, the correct estimation needs to suppose that the protons on the surface of A, are pulled to B, one by one by the least possible power. Since each of the two spheres has curvature then there is a point O, on the surface of A, is the nearest point to B. The electric work done (by B) $w = F\int dx$ in this point is in its minimum form. Since that, we can see sequent operations on this point. In each operation a single proton would move from the point O and pulled towards B, where when be added to the electrons of B, aborts the electric action of one electron. So the electric potential between A & B would decrease in the second operation by the term one while the binding energy inside A, could be considered constant. That is because $n \gg p$ which means that the proton when be lost from A, leads to neither considerable loss in the mass nor decrease in the radius of A. The total operations would appear finally as;

$$G\frac{m(n)}{r}(m\frac{n}{p})\int dp = k\frac{e^2}{R}p\int_p^0 dp \rightarrow G\frac{m^2n^2}{r} = -\frac{1}{2}k\frac{e^2p^2}{R} \qquad (75)$$

where, the huge mass $(m\frac{n}{p})$ *= constat & the negative sign = opposit action.*

The least amount of the binding energy which is required to prevent evacuation and to enable the sphere to orbit is formulated from (74 & 75) as;

$$\therefore\ G\frac{m^2n^2}{r} = \frac{1}{4}k\frac{e^2p^2}{R} \qquad (76)$$

You can see that loss of –even- all the protons in the mind of the left side means loss of mass $= 10^{-12}$ of the total mass (so it is constant), while that in the right side means $p - p = 0$ (mathematics should think sometimes as a physician). Briefly, the estimated minimal energy -to avoid an extra proton- should be done by integral process as one by one. The above 4 subchapters are necessary to the next chapter.

12- The giant atom orbit:

We showed that the giant proton to rotate -by the electric field- in its orbit as one body (or as huge charges but not as individual protons) needs internal gravitational binding energy (the particles by its own gravity bind with each other). From (74 & 76), the least required binding energy has to be in the form

$$G\left(\frac{m.n}{r}\right)\left(\frac{n}{p}.m\right) = k\,e^2 p/4R = \left(\frac{n}{p}.m\right)v^2/_4 \qquad (77)$$

Where; $r = r_c\, n^{1/3}$ is the radius of the sphere of the giant proton, R is the radius of the orbit and $(m.n)$ is the entire mass of the giant proton while $(m\,n \div p)$ is the mass of the huge proton. (From now we will use n to stand for neutrons number of the giant proton). This equation could be considered as the cardinal equation of the orbit from which we can conclude a direct relation between the number of the neutrons n of the giant proton and the average speed v of the giant proton throughout its orbit radius R. So this relation takes the form of; $v^2 = 4\,G\,m\,n^{2/3} / r_c$

Where; r_c is the spacing between particles inside the sphere. Or could be written as

$$v^3 = n\,(4\,G\,m/r_c)^{3}/_2 \qquad (78)$$

Now, let us re-go to the giant proton unit which needs the ratio $\frac{n}{p} = 1.2123 \times 10^{12}$

From equation (70), $v \approx 5.07 \times 10^4\, m\ /s$ this is the velocity of the giant atom orbit in the ground state. It is very near to the astronomic velocity of the mercury planet (the nearest to the sun) which has mean value of astronomic orbital velocity $v = 4.74 \times 10^4\, {}^m/_s$ with error factor in our estimation about $^1/_{1.07}$

Since it is known that our sun losses gradually some of matter in production of heat. It is known that it lost about seven percent of its natal mass [12] so if the present mass of the sun $= 1.99 \times 10^{30}\, k.g$ & if its natal mass was, A

$$A\,(1 - 0.07) = 1.99 \times 10^{30} \rightarrow A = 2.13 \times 10^{30}\, kg$$

By the inverse square law, we have –also- natal orbit speed;

$$v = 1.07 \times 4.74 \times 10^4 = 5.07 \times 10^4\ {}^m/_s \qquad (79)$$

∴ The orbital velocity of the ground state of the giant atom is completely fixed on the natal orbital velocity of the mercury planet $= 5.07 \times 10^4\, {}^m/_s$

This is the circular giant atom orbit, but the astronomic orbit of the mercury planet is elliptical with eccentricity $e = \frac{R_p}{R} = \left(\frac{v_x}{v}\right)^2 = 1.54$ [13, 14]

Equation 78 tells us that the orbiting giant proton possess number of particles just enough to overcome the electric attractive energy. If the orbit was elliptical then this energy would be maximal at the perihelion R_p therefore this quantity of the particles has to be enough to overcome this maximal energy. This means that we have to substitute in (78) at the perihelion (minimal distance). From (77) we can conclude that n^2 *is proportional with* $\frac{R_p}{R}$ therefore we have to multiply n by $\sqrt{1.54} = 1.245$

This is a constant factor should not be introduced in any other mathematic operation. It is a factor just to guarantee that the quantity n is ready to overcome the maximal possible electric energy and to orbit as one body. Putting the value of r_c and putting the value of the average speed v and by substitution in equation 78 which appears now as;

$$1.245v^3 = n\,(4\,G\,\frac{m}{r_c})^{3/2} \qquad (80)$$

So, we can get the number of the neutrons n of the orbiting giant proton;

$$n = 1.245(2.44 \times 10^{45}) = 3.009 \times 10^{45} \qquad (81)$$

This is the least possible quantity of the particles in the orbiting giant proton whose binding energy can overcome the total electric energy at the nearest point (perihelion). From the first equality of equation (77) we can conclude that;

$$p^{\frac{1}{3}} = (\frac{n}{p})^{\frac{5}{3}}\frac{R}{A} \qquad (82)$$

Where, A is a known constant

From the second equality of the same equation we can reformulate:

$$p = m\,(n/p)\,(v)^2\,R \div k\,p\,e^2$$

By dividing over (82)

$\therefore\ p^{\frac{2}{3}} = B(\frac{p}{n})^{\frac{2}{3}}$ Where, B is another known constant.

$$\therefore p = 2.482 \times 10^{33} \qquad (83)$$

Or, we can conclude the value of p directly as

$$p = n\,(p/n) = 3.009 \times 10^{45}/1.2123 \times 10^{12} = 2.482 \times 10^{33}$$

$$\therefore p^2/n = 2.047 \times 10^{21}$$

By substitution in equation 73, (or from the above equations)

$$R = 5.41 \times 10^{10}\,m \qquad (84)$$

Since, the mean value of the orbital radius of the nearest planet (mercury) equals about

$5.791x10^{10}m$ so we have error factor about 1.07 or about the inverse of the error factor of the orbital speed. Since the sun natal mass = $2.13 \times 10^{30}kg$ (85)

From (84), and by using the inverse square law we can estimate the real natal orbital radius;

$$R = (5.791 \div 1.07) \times 10^{10} = 5.41 \times 10^{10}\, m \quad (86)$$

∴The estimated velocity & radius of the orbit of the giant atom in its ground state is fixed well on the astronomic estimated natal velocity & radius of the mercury orbit.

Later on –in a separate discussion- we would see that each a planet was formed of number of these giant charges then in a next stage and after beta decay and formation of atoms the inter-particles distances would increase and consequently the giant charge radius would increase which would lead to inability of the unit to keep its charges which would lead to escape of the charges and consequently attraction and unification of the units to form the planet where Newton's laws would receive the file of the motion as the same R & v and converse it without modification by the same square inverse law in its gravitational form. Unification is not a simple classic addition but it is quantum overlapping of the waves to maintain the same radius &speed. The law is the additive energy (gravitational plus the electric) is constant. This stability is controlled by the count of the additive spheres. As example if in the initial condition, the gravitational energy was about zero while the electric energy was hundred joule, and we have one giant proton in the orbit, then if this giant proton lost half of its charges then fifty percent (of the final condition) of the units would collect to maintain this initial condition and so on.

13- The higher giant state:

The giant atom in its ground state is the smallest inversed giant atom whose giant proton can orbit its giant electron. The inversed atom is the mathematic basis of the giant atom. The created (or the unit) giant charge is the physical unit of the giant charge while the huge charge is the physical basis of the giant orbit. So the ground state is formed of (p) of the huge wave length (λ_u) or p^2 / n timesλ

$$(p^2/n)\,\lambda = (\lambda_u)\,p = 2\pi R$$

The higher levels (the complicated giant charge which represent the planets next to mercury planet) could be constructed by the same above basis. We suggest (recalling equation 54) that; the higher states of the complicated giant proton have number of protons = $p.d$

Where d –in this chapter- means multiplication of (p) of the giant proton by a factor lies between 1 and 10 and so it obeys the relation:

$$1 \leq d \leq 10, \quad (87)$$

Such that, the product $p.d$ means protons of the giant proton times d. We suggest for the complicated giant electron the factor D, where D –in this chapter- is a factor obeys the same relation as

$$1 \leq D \leq 10 \quad (88)$$

Such that D means electrons evacuated giant electron (giant neutron)

From above we can estimate the ratio between mass of the complicated giant electron to that of the complicated giant proton = 1844.

$$M_e \div Mp = 1844 \quad (89)$$

In the giant atom (the ground state) p = p\ where p and p\ are the number of the protons in the giant proton and that of electrons in the giant electron respectively.

In the complicated atom, the system allows that:

The number of the protons in the complicated giant proton = p_1 while the electrons of the complicated giant electron = p_2 such that:

$$P_1 = p\,d \quad (90)$$

$$P_2 = p = p^{\backslash} \quad (91)$$

The equations packet of the higher states:

The motion of the giant proton in a higher state is controlled by;

As a huge proton:

Its angular momentum obeys;

$$[\lambda (p / n)\, d]\, (v / d)\, (m.n / p) = l\,\hbar \quad (92)$$

Where $\lambda = l.\lambda / l = \lambda$ = Bohr wave length and l is the level number = 43

The electric force gives

$$(m.n / p)\, (v / d)^2 = ke^2\, p^{\backslash} \div R.d^2 \quad (93)$$

Where p\ = number of electrons in the giant electron = p

We can notice that the mass of the huge proton in the complicated giant proton still equals; $m.n / p$

As a giant proton:

The electric force gives

$$[(m.n)\, d]\, (v / d)^2 = k \frac{pd}{Rd^2}\, e^2.p^{\backslash} \quad (94)$$

Where the big bracket is its mass, $(e.p^{\prime})$) is the number of the electrons in the complicated giant electron while $(e.p.d)$ is the number of the protons in the complicated giant proton.

14- The end of Compton state:

The matter density in condensate like nucleus and neutron star is about 5×10^{14} g/cc (with particle spacing about $2 \times 10^{-15}m$). In such high density β decay is forbidden because decay results in excess particles leading to decrease spacing between particles but neutron degenerate refuse -by Pauli's exclusion- this decrease [15,16]. Our condensate model differs from neutron star and consequently needs deep insight. First, we don't now search for how such high density was formed. Let us begin -at least here- from the point; if such sphere had exist (perhaps in early universe) then the study would only search in physics of such sphere. In the giant charge unit neutron decay is not forbidden but it has no chance. No chance because the time need for GCU to grow into Gc equal $dt = t_o = 0$ (as we say that the moving body has mass more than the rest one where this excess mass needs no time). Since, -in the alternative relativistic solution- the rest length equals the relativistic length so, the zero time in this solution is really zero time where no time dilatation. But β decay is exponential function needs timeΔt. β decay is not forbidden in GC because it would (unlike neutron star) not lead to decrease spacing. Although the density of matter is very high yet the net binding energy is very weak. As we showed all energies were withdrawn and transformed into particles except the little residual energy. When β decay produces excess particles which of course need to occupy space then instead of increase of the density there would be other solution suitable for the giant atom which is escape of the charges. Now, β decay inside the giant charge means production of excess protons which would do repulsion with the initial protons. Production of excess charges would lead to that the left side of the inequality form of equation 74 would lead to that, the protons of the giant proton (and the electrons of the giant electron) would be attracted together as singled particles. This would result in evacuation of the sphere from the charges. After that, excess β decay would lead to formation of the atoms and consequently much increase of the inter-particles distances giving increase in the radius of the giant charge and consequently decrease in the gravitational binding energy inside the giant charge which would result in escape of any residual charges of the giant orbit (you have to go back to equation 75 in its inequality form) and so it appears as evacuated giant sphere (neutral body formed of atoms). This would results in attraction of these neutral bodies by the effective gravitational field and so allowing the identical orbitals (having the same number of waves and the same wavelength –as in equation 67- of the same planet) to interfere and form finally the solar system. The classic dynamics would receive the file of the orbital motion to preserve it without modification. This means that the emergent deficit in the initial condition (electric giant atom) is treated urgently and definitely by overlapping the waves of the identical orbitals of the units of the same planet (and of the sun units). This means that the total energy (E_g+E_e) is conserved by the interference of the identical orbitals (which have the same wavelength). The initial condition at the giant charge appeared as; $E_e + \sim0 =$ the final condition (after union of the units of the same planet and union of the units of sun) $= 0 + E_g$

From the equality mentioned in equation 21, the giant electron needs number of particles 1840 times as massive as the giant proton, hence, the latter orbits around the first. Hence, we can define the orbit length R_S and the orbital speedv_S.

In the stage of the neutron decay the familiar atoms are formed, consequently, the next results would be established:

1- r_c *and* v inside the sphere S would vanish and the free charges escape from the sphere
2- The electrostatic potential between the giant electron and its giant proton vanish.
3- the Newtonian gravitational potential would predominantly receive the file of the orbital motion to conserve R_S & v_S

15- The solar system:

We know that the solar system is formed of nine planets rotate around the sun. The nearest one to the sun is mercury which has orbit radius $= 5.8x10^{10}m$ and orbital speed $v = 4.74 \times 10^4 m/s$.The following table shows the relative parameters which the planets obey [17, 18, 19, 20]

	Mercury	Venus	Saturn	Pluto
v	$1(= 4.74 \times 10^4 m/s)$	1/1.36	$\frac{1}{5}$	$\frac{1}{10}$
R	$1(= 5.79 \times 10^{10} m)$	$(1.36)^2$	25	100

Our suggestion states that; each planet had formed (historically) of similar and homologous units. The number of the planet units could be concluded by dividing the planet mass over the mass of the giant proton. Each of these units had behaved as a giant proton. Each planet unit had a sun which had behaved as a giant electron.

The planet unit had rotated –on a base of quantum mechanics– around its sun unit forming a system of "giant atom".

The old system had finished by union of all the sun units to form one "sun" and union of the identical planet units to form one planet (interference of the identical orbitals). So the different planet units had formed nine planets. So – now – we have one sun and nine planets. We also suggested for the solar system the following:

The units of the same planet had the same R & v therefore after beta decay they pulled to each other and collect in one body mass. Also do the electrons evacuated giant electrons. So we would have one planet orbits its special sun. The units of another higher state have another v *and* R therefore they collect in a higher level with radius of orbit = $R.d^2$

Because of the radii of the orbits of the units of the different suns are not so away from each other comparative with the units of the different planets so they collect in one mass that is; one sun and nine planets. Mercury orbit represented the ground state of the solar system motion. The higher planets obey; $R^{\backslash} = R.d^2 \rightarrow v^{\backslash} = v/d$.

16- The ratio "Ms ÷ Σ M_p"

It is the ratio between mass of the sun and the summed masses of all planets.

Our estimation gave; $Ms \div \Sigma Mp = 1840$ (95)

The astronomic ratio ≈ 600 where the sun natal mass = $2.13 \times 10^{30}\ kg$ [12]

Therefore, there is error in our estimation = $1840 \div 600 = 3$

So we suggest for dealing this error that; there were 3 orbiting giant protons for each giant electron as; (O, y, z), (x, O, z) & (x, y, O).

$\therefore Ms \div \Sigma Mp = 1840 \div 3 = 600\ times.$ (96)

Three orbiting giant protons for each giant electron should make elliptical orbit (even in the ground state) and give spatial shape as if it was real giant atom.

Union of the three orbits (overlap of their waves) in the Newtonian stage may explain the final shape of the orbit.

17- The giant charge interior:

After we knew physics of Compton sphere and how it replicated till it becomes giant charge then this giant charge is the final macroscopic product. Its interior would forget the entire microscopic events and would remember only; the huge charge (which is formed of one charge and $\frac{n}{p} \approx 1.2123 \times 10^{12}$ neutrons) is the unit of GCU.

We discussed all the energetic terms inside our sphere. Because the pair term of this sphere depends on the spin coupling interaction of its nucleons [21] & it's odd or even number (as in the liquid drop model of the nucleus) and because the pairing term decreases with the even mass number A and equals zero if it was odd [22] and because A of the Compton's sphere is very great so we can consider the energy of this term neglected if compared with u_G Any way, we can consider the mass number is odd so the term equals zero. We have also to remember that all the equations of the Compton's sphere are constrained and directed mathematically to realize the initial conditions

Conclusion

The giant atom-like system is not speculative suggestion because it is confirmed by what we found as complete coincidence between the parameters of such a system and that of the solar system. Such a system carries the scientific seeds of physics of the relativistic baryogenesis.

Appendix

Actually Lorentz postulated that the intrinsic energy of the charged particle is due to its electromagnetic behavior [9]. So let us estimate the part of the electromagnetic energy due to the electric field and add it to that part due to the motion (spin) of the particle (magnetic energy). Now in each infinitesimal volume we have the electric energy density in the form of; $(\Delta E)_1 = \omega (E.E) / 2$. Where ω is the permittivity constant of space and (E.E) is the dot product of the electric field vector (the result is scalar). And all over the spherical volume we have the electric potential per particle

$$u_e = \frac{e^2}{32\pi^2 a^4 \omega} \int_0^{2\pi} \int_0^{\pi} \int_r^{\infty} r^2 \sin\theta \, dr d\theta d\phi = \frac{e^2}{4\pi\omega(2a)} = \frac{1}{2} m_o c^2$$

Where ω is the permittivity constant. We would estimate the magnetic field B in z- direction (in S.I. units) postulating a literal circular motion of the charged particle with radius of rotation equals its classic radius $a = r$. So we would estimate the magnitude of B in z-direction due to motion of the charged elementary particle in a circle with length $l = 2\pi a$ where a = r. From Biot-Savart law in its simple form: $B = \frac{\mu}{4\pi} i \frac{\int dl}{a^2} = \frac{\mu i}{2r}$ where μ is the permeability constant of the space and i is the electric current of the charged particle as; $i = \frac{e}{T} = \frac{ev}{2\pi a} \rightarrow B = \frac{\mu e v}{4\pi a^2}$. The magnetic moment is estimated as: $m = i\pi a^2$

$\therefore$ The potential energy due to spin $= u_s = -\boldsymbol{m}.\boldsymbol{B} = \frac{v^2}{4\pi 2a} e^2 \mu = u_s$

Put $v = c$ and put $\omega\mu c^2 = 1$

$\therefore u_s = \frac{e^2}{4\pi\omega(2a)}$ or, we can estimate it directly from Maxwell equations as;

$(\Delta E)_2 = B^2/2\mu = E^2 \varepsilon / 2$ *where* $B = -E/c$,

And the total energy is estimated by adding the two parts of energy

$$\therefore u = \Delta E = 2\frac{e^2}{4\pi\omega(2a)} = m_o c^2.$$

If we applied the above mathematic manipulation in equation 2 (the giant charge unit) then either in the macroscopic state (rest state) or the microscopic state ($v \approx c$) the result would be the same

$$\frac{1}{2}m_o c^2 + \frac{1}{2}m_o c^2 = \frac{1}{2}\left(k\frac{e^2}{r_o} - \frac{k\frac{e^2}{r_o}n}{px\mu} + \frac{k\frac{e^2}{r_o}n}{px\mu}\right) + \frac{1}{2}\left(k\frac{e^2}{r_o} - \frac{k\frac{e^2}{r_o}n}{px\mu} + \frac{k\frac{e^2}{r_o}n}{px\mu}\right) \text{ Where, } \frac{k\frac{e^2}{r_o}n}{px\mu} = u_g$$

$$k\frac{e^2}{r_o}\left(\frac{r_o}{r_c}\frac{p^{\frac{2}{3}}}{(\frac{n}{p})^{\frac{1}{3}}}\right) = m_o c^2. \text{ Where, the product inside the brackets =1.}$$

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HADRONIC JOURNAL 43, 51 - 59 (2020)
DOI 10.29083/HJ.43.01.2020

NEW THERMODYNAMICS: REVERSIBILITY AND FREE ENERGY

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Received July 23, 2019
Revised November 28, 2019

Abstract

Most accept that thermodynamics is a mature science. It will be discussed that reversibility can be an illusion. Furthermore, new explanations that do not require the parameter entropy will be given for free energies. Moreover, it will be shown that entropy's removal clearly lends itself to the science's simplification, at least in so far as free energies are concerned.

Keywords:

Entropy, Gibbs free energy, Helmholtz free energy, Reversibility

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Introduction:

This paper is a continuation of this author's previous paper "Resolving Problematic Thermodynamics" [1], which described an alternative thermodynamic narrative. In that paper, I stated that free energies are to be left to future discussions, hence this paper.

Interestingly, Norman and Dunning-Davis [1] point out that "probabilistic ideas are usually, if not always, used in physics when some vital pieces of information needed for a truly exact solution are missing". Yet such probabilistic arguments form thermodynamics' accepted basis. This has lent itself to the emboldened assertion that probabilities give reasons in different scientific realms. Have we lost sight of prob-abilities original structure that being a mathematical expression providing plausible results? If so, then certain accepted statistical arguments may be self-serving for those believing that thermodynamics is a mature science.

What if probability based statistical thermo-dynamics is based more upon mathematical conjecture than constructive logic? How would one show that to be the case? Probabilistic arguments would not provide the necessary yet missing vital information! Perhaps showing that simpler alternative explanations based upon constructive logic is the best answer.

Three fundamental enshrined thermodynamic principles are reversibility, Gibbs free energy, and Helmholtz free energy. So herein we shall investigate the illusion of reversibility and then show that alternatives explanations for both free energies can be obtained. Note; free energies describe the energy that can be extracted from systems.

The accepted writing of energy change and work associated with an expanding system, in terms of isothermal entropy change is:

$$TdS = dE + PdV \quad (1)$$

Where T is temperature, S is entropy, E is internal energy, P is pressure and V is volume.

An inherent problem with eqn (1) being that PdV lacks clarity [1]. This author realized that the work as defined by PdV, is "lost work" done onto the surrounding atmosphere [1,3,4] by an ex-panding system i.e. an energy transfer from the expanding system into the massive surrounding atmosphere, which remains both isobaric and isothermal [1,3]. "Since, after expansion the system is at the same pressure and temperature as the atmosphere, then the atmosphere cannot return either work or energy back into the expanded system. Thus PdV is lost work i.e. irreversible work" [1,3,4].

Giving eqn (1) clarity and rewriting it in terms of the first law by considering the energy input (dq) into an expanding system, gives:

$$dq = dE + (PdV)_{atm} \quad (2)$$

At this point we must emphasize that as was previously discussed intermolecular collisions are not necessarily elastic, as is traditionally professed [1,4,5]. This provided clarity as to why pressure temperature (P-T) relationships exist [1] i.e. increase P and T tends to increase.

Hence $(PdV)_{atm}$ represents some combination of an atmospheric potential energy and/or heating of the atmosphere through viscous dissipation [4,5]. The fact that $(PdV)_{atm}$ signifies lost work alters our perceptions of entropy and the second law [3]!

Concerning My Previous Paper:

Equation (10) in my previous paper [1] concerning the relationship between iso- baric (C_p) and isometric/isochoric (C_v) heat capacities, the temperature change on the L.H.S. of the equality was unfortunately not included. Hence the eqn (10) should have been written as[1]:

$$(C_p dT)_{sys} = (C_v dT)_{sys} + (PdV)_{atm}$$

I.e. the isobaric heat capacity includes the work done onto the atmosphere (PdV_{atm}) plus the energy required for the system's temperature increase ($nC_v dT$).

Illusionary Thermal Reversibility in Boiling

Consider a boiling liquid below a piston-cylinder, as shown in Fig 1. The expanding gas in the piston-cylinder does irreversible lost work onto its surrounding atmosphere i.e. $(PdV)_{atm}$. The energy in (dq_{in}) is defined by the following first law based equation:

$$dq_{in} = dE_{sys} + (PdV)_{atm} \qquad (3)$$

The mass transfer from the liquid to vaporous state drives the expansion by being infinitesimal- ly hotter with an infinitesimally higher pressure than the surrounding atmosphere. Note: In order for the approximation of $dP=dT=0$, to hold then Eqn (3) assumes that the expanding system is fully insulated hence and that its expansion is quasi static.

In normal boiling the change to the system's internal energy (dE_{sys}) equals its change in bonding energy (dU) i.e. the change in inter-molecular bonding energy when going from the liquid to the vaporous state. Accordingly, eqn (3) can be rewritten as:

$$dq_{in} = dU + (PdV)_{atm} \qquad (4)$$

Consider that the heat is turned off ($dq_{in}=0$) and that the insulation is now removed, as shown in Fig 2. As vaporous molecules condense, energy (heat from the molecule' bonding energy) slowly vacates outwards through the condensing system's walls. Understand that the work done onto the atmosphere [$(PdV)_{atm}$] during boiling was lost [1,3], hence it cannot magically return during condensation!

We know that no actual work is done onto System 1during condensation because its pressure, temperature and mean molecular volume all remain relatively constant. Herein, System'1 total volume decreases as vaporous molecules condense back into the liquid state.

Of interest: As System 1's total volume decreases then some of the atmosphere's potential energy will be transformed into kinetic energy (A.K.A. infinitesimal heat)[1]. Mathematic-ally it is as if a VON (volume of nothingness) [1] was removed from the base of the atmosphere.

During condensation, the heat leaving the system dissipates into the surrounding atmos-phere as defined by:

$$dq_{out} = -dU = -dE_{sys} \qquad (5)$$

Since the magnitude of eqn (5) is less than eqn (4) by lost work $[(PdV)_{atm}]$, then boiling is an irreversible process, although it can possess the visual illusion of being reversible!

If one could somehow collect and then measure the dispersing thermal energy leaving the system during condensation, one would determine that in terms of magnitudes:

$$\left|(dq_{in})_{Fig1}\right| = \left|(dq_{out})_{Fig2}\right| + \left|[(PdV)_{atm}]_{Fig1}\right| \qquad (6)$$

It must be emphasized that the casual observer has never actually measured the heat out (dq_{out}), i.e. in other words he/she traditionally (wrongly) assumed that: $dq_{out} = -dq_{in}$. Ultimately, the casual observer simply visually witnesses the system continually maintaining mechanical pressure equilibrium as heat (dq_{out}) slowly disperses out from the condensing system.

The above has also left most with the miscon-ception that the atmosphere can do work onto a system whose pressure is also atmospheric.

To emphasize; one can readily measure the latent heat/enthalpy of vaporization in an isobaric calorimeter, i.e. herein eqn (4) defines the heat of vaporization, which equals dq_{in} . However, based upon the illusion of reversibility, we have assum-ed (wrongly?) that the magnitude for heat of condensation equals that for vaporization. If one could actually measure the heat of condensation it would be determined to equal eqn (5)!

The above clearly challenges the accepted considerations of reversibility, which often involves (wrongly?) statistical arguments. This alone changes the way thermodynamics is contemplated.

***Gibbs free energy*:**

In deriving his free energy, Gibbs started off with eqn (1), and then subtracts the following total differential [6]:

$$d(TS) = dE + d(PV) \qquad (7)$$

Logic dictates that one should start off with a total differential, from which its partials are determined. A reason that this absurdity of subtracting a total differential from a partial differential to obtain the other parts was acceptable is it gave isothermal entropy change relations [i.e. eqn (1)] a sense of supremacy, something that this author challenges.

Eqn (7) wrongly treats both dE and $d(PV)$ as if they are part of the same system. Logic dictates that if PdV in eqn (5) is work done external to the expanding system then $d(PV)$ is also external[1] i.e. it renders eqn (7) into an absurdity.

Consider that the energy required for an endothermic reaction comes from the thermal energy contained within a system: $dU > 0$, and: $dT < 0$. If these are the only system changes then one could use the isometric molar heat capacity and write for n moles of molecules.

$$dU = -nC_v dT \quad (8)$$

Eq. (8) assumes that there is no change to the mechanical parameters i.e. neither a volume nor pressure change.

Next consider that the system experiences an isometric pressure change as is illustrated in Figures 3 and 4.

There is no actual work done onto/into the rigid closed & insulated system! But there is a pressure decrease and based upon the *P-T* relation; there should be an associated temperature change. Can we now write?

$$dU = -nC_v dT + VdP \quad (9)$$

Considering eqn (9); in a 100% insulated isometric system part of the witnessed temperature change would be caused by the pressure change! I.e. if there were no other changes to the system, and its pressure increased, then so too would the system's temperature! Conversely, if the pressure decreased so to would its temperature.

Can we say that VdP in eqn (9) is the energy associated responsible with the above system's temperature changes? I.e. is the energy associated with the natural *P-T* relation. Then for closed insulated experimental systems, it also relates to the ideal gas law i.e. $VdP = NkdT$. Note; the ideal gas law, Avogadro's hypothesis etc. are now considered as being limited to sufficiently dilute gases in closed systems, i.e. most gaseous experimental systems [4,5].

It must be emphasized that we have not discussed any reaction in particular rather we seek an understanding of how the parameters relate to one and another.

Based upon eqn (9), the energy that could now be theoretically extracted (G_{ex}) from the system becomes:

$$G_{ex} = dU - VdP + nC_v dT \quad (10)$$

The change in chemical potential can also be written in terms of the number of molecules (N) and the molecular chemical potential i.e. $dU = d(N\mu)$. Compare eqn (10) to the following Gibbs-Duhem relation:

$$G = Nd\mu - VdP + SdT \quad (11)$$

If $S=nC_v$ then eqn (10) is eqn (11).

Our new realizations are certainly plausible however before they can be accepted one must similarly reinvestigate Helmholtz free energy.

Helmholtz free energy

Consider an endothermic reaction that requires energy from an external source i.e. $dU>0$. Fig 5 shows System 1 in State 1 being heated, thus providing energy ($dq_1=dE_1$).

Note; we start with $dF_{ex}=0$.

The result: System 1 is transformed into expanded State 2. Since an isobaric volume increase occurred then work is done onto the surrounding atmosphere [$W=(PdV)_{atm}$] as shown in Fig. 6.

Next consider that the temperature of State 2 is higher than that of State 1, hence the thermal energy required for the temperature increase is nC_pdT.

If dU equals the change to the system's chemical bonding energy, then the energy change in going from State 1 to State 2 is defined by:

$$dq_1 = nC_pdT + dU \qquad (12)$$

The isometric heat capacity (C_v) does not include the work done/lost [$(PdV)_{atm}$]. Therefore, in terms of isometric heat capacity eqn (12) becomes:

$$dq_1 = nC_vdT + (PdV)_{atm} + dU \qquad (13)$$

Consider that energy is now extracted from State 2: $dF_{ex}>0$, then eqn (12) becomes:

$$dq_1 = nC_pdT + dU + dF_{ex} \qquad (14)$$

The energy (dF_{ex}) that can be extracted from State 2 becomes:

$$dF_{ex} = dq_1 - nC_pdT - dU \qquad (15)$$

Ultimately, dF_{ex} is a generality for the maximum amount of energy that can be extracted from a system in order to perform work, i.e. move a car.

Consider the case of no heat/energy input ($dq_1=0$) hence eqn (15) becomes:

$$dF_{ex} = -nC_pdT - dU \qquad (16)$$

Eqn (16) implies the extraction of negative energy, which is not realistic. However, if the chemical reaction is now exothermic then: $dU<0$. The maximum amount of energy that can be extracted from this exothermic reaction becomes:

$$dF_{ex} = |dU| - nC_pdT \qquad (17)$$

Rewriting in terms of molar isometric heat capacity (C_v) and work done onto the atmosphere [$W=P_{atm}dV_{sys}=(PdV)_{atm}$]:

$$dF_{ex} = |dU| - nC_vdT - (PdV)_{atm} \qquad (18)$$

Eqn (18) is a traditionally accepted change to Helmholtz free energy (dF) for an exothermic chemical reaction i.e.:

$$dF = |dU| - SdT - PdV \qquad (19)$$

Comparing eqn (18) to eqn (19); they are one and the same if: $S=nC_v$. If there were no chemical reaction ($dU=0$) then the maximum amount of energy/work that could be extracted becomes:

$$dF_{ex} = -nC_v dT - (PdV)_{atm} \qquad (20)$$

Compare eqn (20) to an accepted equation for changes to Helmholtz free energy (dF):

$$dF = -SdT - PdV \qquad (21)$$

Again, entropy (S) seemingly equals the number of moles times the isometric molar heat capacity (nC_v). Certainly, the traditional writing of PdV i.e. eqn (21), lacks the clarity[1] that eqn (20) possesses.

Discussion:

We can now argue that traditional considerations for both Gibbs free energy and Helmholtz free energy were sort of right but for the wrong reasons.

Is entropy based thermodynamics really necessary, or is it a mathematical contrivance [7] resulting in the science's over-complication. Certainly, unlike entropy based equations, eqn 10 and eqn 20 are readily envisioned.

This author's further asserts that other accepted equations such as the Clausius-Clapeyron equation can also be explained without entropy. Ditto applies to chemical equilibrium. These all may be discussed in future papers.

Conclusions:

In boiling one can readily measure the energy required to break the liquid's intermolecular bonds (dU) plus the work done onto the surrounding atmosphere due to isobaric expansion [$W=(PdV)_{atm}$] i.e. latent heat/enthalpy of vaporization.

Conversely, the heat of condensation is not so readily measured! Rather we simply have assumed that its magnitude equates to that for vaporization. This erroneous assumption was accepted, in part, because of the illusion of reversibility in closed system boiling.

Based upon heat capacity, temper-ature change, bonding energy, lost work and natural P-T relations, simple logic based constructive formalizations for both Gibbs free energy and Helmholtz's free energy were obtained. Note: VdP in Gibbs free energy attained clarity by realizing that intermolecular collisions are inelastic [1,4,5].

Abiding by Occam's razor, one soon realizes that thermodynamics without entropy is clearly a logical choice. This does not necessitate the removal of complex statistical based arguments rather it demonstrates the power of clear logic over the traditional mathematical driven science. Certainly, an acceptance of what is stated will alter how we structure thermodynamics.

Figures

Fig. 1: Shows isobaric isothermal boiling i.e. the mass transfer from a liquid to va-porous state resulting in expansion.

Fig. 2: Shows condensation i.e. removing both the heat and insulation from Fig. 1. This allows the system to return to its original state thus providing the illusion of being reversible.

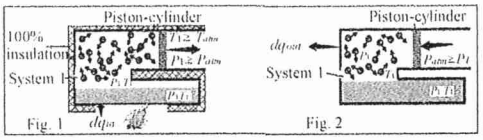

Fig. 1 Fig. 2

Fig. 3: Shows a system of n moles of gas as reactants for an endothermic reaction.

Fig. 4: Shows a gaseous system as the products of the reaction shown in Fig. 3.

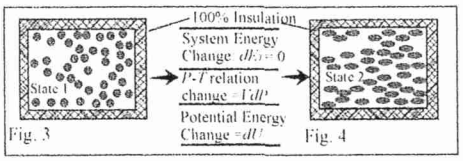

Fig. 3 Fig. 4

Fig. 5: Shows the heating of a system of n moles of gas as reactants in an endothermic reaction.

Fig. 6: Shows that the gaseous system shown in Fig. 5 has expanded hence performs isothermal and isobaric work onto the surrounding atmosphere.

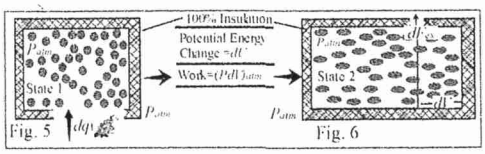

Fig. 5 Fig. 6

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HADRONIC JOURNAL 43, 61 - 77 (2020)
DOI 10.29083/HJ.43.01.2020

DARK MATTER, DARK ENERGY AND RELATED TOPICS IN THEORETICAL PHYSICS

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Received March 16, 2019

Abstract

The work is devoted to a detailed analysis of the fundamentals of general relativity and related theories and hypotheses. The basic experiments underlying the general theory of relativity are critically analyzed. Consideration also involves modern experiments allegedly confirming this theory. The problems concerning numerous consequences of general relativity, such as the Big Bang theory and relativistic cosmology, are highlighted. Also addressed the problems associated with the concepts of dark matter and dark energy. The recent experiments on the detection of gravitational waves are considered in detail. Critical analysis shows the need to return to the classical concepts of space and time and to build a theory of gravity on this solid basis.

Keywords: general relativity theory; dark matter; dark energy; Big Bang; gravitational waves.

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1 Introduction

The general theory of relativity (GTR) and related ideas are traditionally considered advanced science: the big bang hypothesis, relativistic cosmology, studies of so-called dark matter, dark energy, etc. A huge number of papers [2,5-7,11,12,15,18,19,22-24] are devoted to this research, including books, conferences, broadcasts and films.

GTR contains rather original ideas, for example, the equivalence principle, expressed through the idea of geometrization. In the case of correctness of the basis of the general relativity, it could claim the status of a scientific hypothesis about the amendments to the static law of Newton. For the sake of justice, it should be noted that GTR has never been universally recognized as an alternativeless theory. The flow of fair criticism of this theory did not cease from the very beginning of its emergence (see, for example, [1,3,4,9,13,16,17] and references therein).

The main objectives of this paper are as follows:
– the detailed analysis of the initial GTR base;
– the analysis of new confirmations of GTR;
– the analysis of the Big Bang theory and relativistic cosmology;
– the discussion of issues related to dark matter and dark energy research;
– the analysis of recent experiments on the detection of gravitational waves.

2 Some Remarks on the General Theory of Relativity

Let us start with the general theory of relativity (GTR). Many of the difficulties of GTR are well known [1]:

1) the principle of conformity has been violated (without introducing artificial external conditions, there is no limit to the case without gravity);

2) there are no conservation laws;

3) the relativity of accelerations contradicts the experimental facts;

4) there are singular solutions.

Usually, any theory is considered inapplicable in such cases, but the theory of relativity to preserve its "universal character" begins to build fantastic images: black holes, the Big Bang, etc.

The presence of singularities or the multiconnectity of the solution means that at least in these areas the solution is not applicable. Such a situation takes place with a change in the signature of space and time for the "black hole" in Schwarzschild's decision and one should not look here for any artificial

philosophical meaning. The non-observability of "black holes" follows even from GTR: the time of formation of a "black hole" will be infinite for us as remote observers (even if we had waited for the end of the World, no single "black hole" would have time to form). However, since the collapse cannot end, there are no sense to discuss solutions which consider as if everything would be already happened. The separation of events for an internal and external observer by infinite time is not "an extreme example of the relativity of the course of time", but an elementary manifestation of the inconsistency of the Schwarzschild solution. The "incompleteness" of solution systems demonstrates the same fact.

The use of non-inertial systems in GTR is internally contradictory: in a rotating system, sufficiently distant objects will move at a speed greater than the speed of light (according to the special theory of relativity - STR - and GTR, the apparent speed must be less than c). However, there is an experimental fact: a photograph of the sky from the rotating Earth shows that visible solid-state rotation (classical) is observed. The use of a rotating system (for example, the Earth) does not contradict classical physics at any distance of the object from the center, while in GTR the magnitude of the component g_{00} becomes negative, and this is unacceptable in this theory. How to be with observations in terrestrial astronomy?

The concept of time in GTR is also confusing. What is this clock synchronization, if it is possible only along unclosed lines? A change in the moment of the initial time reference during a crawl along a closed path is a clear contradiction of GTR, since at a high synchronization rate one can make many such crawls and get an arbitrary aging or rejuvenation.

Games with the properties of space-time lead to the fact that in GTR the use of variational methods is in doubt: the quantities are not additive, the Lorentz transformations are non-commutative, the integral quantities depend on the path of integration.

Now about the experimental substantiation of GTR [1]. Usually, even if there are hundreds of different data, a theory is not always built - it is easier to put the data into a table. In the case of GTR, we have the "Great Theory of Three and a Half Observations," of which three are fiction. Regarding the deviation of light in the gravitational field from the rectilinear motion, we must say the following. First, as noted by most experimenters, the quantitative confirmation of the effect essentially depends on the faith of a particular

experimenter. More information about what Lord Eddington actually measured can be found in article [8]. Secondly, already from the classical formula $ma=\gamma mMrr3$ it follows that any object, even zero and negative mass, will fall in the gravitational field. Thirdly, with what, in fact, is the effect compared? With absolutely empty space? As early as 1962, a group of Royal Astronomers stated that the deviation of a ray of light near the Sun cannot be considered as confirmation of GTR, since the Sun has an atmosphere extending a great distance. Recall that the phenomenon of refraction has been taken into account for the Earth's atmosphere by astronomers for a very long time. More Lomonosov discovered the deviation of a beam of light in the atmosphere of Venus. For clarification, imagine a glass sphere. Naturally, parallel rays (from distant stars) will deviate in it to the center. Such a system is familiar to all as an optical lens. A similar situation will be for the gas sphere (solar atmosphere). To accurately calculate the deflection of a ray of light in a gravitational field, it is necessary to take into account the presence of the solar atmosphere, density and temperature gradients along the path of the ray, which cause a change in the refractive index of the medium (and curvature of the ray of light). And if at a distance of hundreds of meters near the earth's surface these effects cause a mirage, then ignoring them for a ray from a star passing millions of kilometers near the Sun is pure speculation.

Of course, the displacement of the perihelion of Mercury is a beautiful effect, but whether it is enough only one specimen for "attracting scientific theory"? It would be interesting to check it near solids, so that its value can be unambiguously estimated. The fact is that the Sun is not a solid body, and the movement of Mercury can cause a tidal wave on the Sun, which in turn can affect the displacement of the Mercury perihelion. In any case, it is necessary to know the speed of transmission of gravitational interactions to calculate the effect of the tide from Mercury and other planets on the characteristics of the orbit of Mercury. When calculating the perihelion displacement in GTR (from a strict solution for a single attracting point), it seems that we know the exact masses of astronomical bodies. But in fact, if we use GTR as an amendment to Newton's theory, then the situation is the opposite: the task is apparently to restore the exact masses of the planets, then to substitute them for testing GTR. Imagine that the orbit of the planet is circular. In this case, it is immediately obvious that the rotation period in Newton's theory will already be taken in view of the invisible precession, that is, it is renormalized period.

Therefore, the renormalized masses are already included in Newton's theory. Since the GTR corrections are many times smaller than the perturbing influence of all planets and the influence of non-sphericity, the recovery of exact masses in this complex many-body problem can significantly change the description of the entire motion pattern. It is not taken into consideration anywhere.

Generally speaking, the situation with the description of the perihelion displacement of Mercury is typical for the relativistic behavior. First, it is declared that the effect was predicted, although Einstein compared it with the well-known results of the approximate Laplace calculations obtained long before the creation of GTR. We hope everyone understands the huge difference between "predicting" and "explaining in hindsight." Secondly, precession was in classical physics also: according to the 19th century data, the total value of precession due to the influence of some other planets was calculated as *588″*, and the missing calculated value was only about *43″*, that is, it is a small amendment. (Note that according to some data of the 20th century, the total precession value is indicated by almost an order of magnitude greater, but the value of *43″* is "*taboo*"; however, we will not seek fault on trifles from 1/3 of the "huge experimental base of GTR"). Thirdly, even modern mathematics is not able to perform an exact calculation in the many-body problem. In the classical case, the calculation was carried out as the sum of independent corrections from the influence of individual planets (in pairwise interaction, the Sun and the planets were considered material points). Naturally, in the classical case, the final result (already more than 90 percent of the observed!) can still be improved. It is necessary to take into account the non-sphericity of the Sun (an experimental fact!), the influence of all the planets and small bodies of the Solar System and the fact that the Sun is not a solid object (material point). It has a differential rotation, and its local density in different layers is simply obliged to "track" the influence of other moving planets. On this way of attracting more real specific physical mechanisms, the missing small effect can well be found. But the declaration of relativists is an incomprehensible speculation to the mind! They "find" the effect (and only this small percentage), having considered the movements of only two material points – the Sun and Mercury. Sorry, but how will your GTR correct most of the effect already found from the classics? Are you afraid to count? Then what kind of "brilliant coincidence" are you saying?

Pure fit to your desired! Besides, and the work of the founder of relativism with the "explanation" of the displacement of the perihelion of Mercury [6] contains elementary mathematical errors [14]. He did not notice that the roots of the obtained cubic equation are related by Vieta's formulas, and the resultant effect turns out to be strictly zero.

The Hafele-Keating experiment was announced as confirming GTR. However, this conclusion was obtained on the basis of a small sample. Other researchers who obtained access to the same primary data made the opposite conclusion. At the same time, the Hafele-Keating experiment was interpreted in favor of the dependence of time on gravity (interpretation actually means a change in the generator carrier frequency itself in the gravitational field). However, in this case, it contradicts the interpretation of the Pound-Rebka experience, where it was believed that the generator gives the same frequency at any height (and one of the experiments should be excluded from the piggy bank of the theory of relativity). It would be nice for theoreticians to listen to those whom they called the modest and inconspicuous word "observer" [10] to find out: "what really is." After all, it was these "observers" who participated in the creation of the "primary reference system" (WGS-84, PZ-90, GLONASS, NAVSTAR GPS), contrary to the STR postulates, introduced amendments to the motion of the Earth's surface relative to navigation satellites, etc. There is no time for practice (surveyors, engineers, inventors, experimenters) to listen to "retroactive explanations from theorists." So, satellite TV generators NAVSTAR GPS are tuned at the Earth to a frequency of 10.2299999945 MHz so that in orbit the frequency of the generator rises to 10.23 MHz in strict accordance with the Eötvös effect known before STR. Thus, long-term navigation experiments refute a single experience with "flying airplanes".

In the review [22], some new "successes" in the verification of general relativity are pathetically promoted. Thus, in [18], the principle of mass equivalence is discussed, ostensibly taking into account the gravitational coupling energy (by delaying the laser signal sent from the Earth and reflected from the Moon). This problem is completely contrived and does not depend on the "immense size", since the equality of the masses is already incorporated in the quantitative determination of the magnitude of the gravitational constant (and the energy of the gravitational coupling is local, since the principle of close interaction is proclaimed). Attracting cosmic

scales rather worsens the situation, due to the uncontrollability of many parameters. So, in space there exist a medium and fields that affect the propagation of a signal; even the problem of three material points is not solved exactly, and the number of objects in the Solar System is even greater; the exact mass values of astronomical objects are unknown; all objects are in motion (not inertial) and have complex (non-point) forms; geophysical processes are not taken into account (for example, there is no exact theory of tides, and they manifest themselves not only on water, but also on land surface).

Further, there are a number of doubts on the results of [12,15], using radio interferometers with a super-long base. None of the experiments is direct (but only interpretations). The exact mass of the Sun is unknown. And who can determine the exact distances to the Sun or to the vehicles, if the exact path is unknown (it will not be rectilinear, since it depends on the presence of the solar corona, characteristics of the plasma propagation medium)? How can you determine the accuracy of the path difference for a long base taking into account the uncertainty of all angles, the presence of density and plasma temperature gradients? None of the delay times τ can be controlled (i.e., everything is tied up with faith!). Since the phase delay was not subordinate to GTR, a "group delay" was invented to fit under the results (the statistical analysis followed the same purpose). Many ideas about the processes were of a model nature, but since so many models are introduced, then what is being verified? Similarly, whether not too many parameters "were tested" by **only one** experience [23] with the lunar laser ranging? The value to be checked must also be **only one** (under the condition of all other known parameters). Regarding declarations [24], where primary data are not provided, a number of observations can also be made. The Earth and the Moon are not inertial systems (move in space with acceleration); there is no way to control the distance to the reflectors and the constancy of the speed of light (the properties of the propagation medium change); neither the mass shape of the participating objects, nor geophysical processes are taken into account. By the way, information about the radar observations of Venus, which confirm classical physics (the classical law of velocity addition), can be found in [20,21].

In [2,7], a microwave communication system aboard the Cassini spacecraft is used for "evidence". Despite such a variety of methods, the

disadvantages are the same: the exact distributions of density, temperature, fields in the plasma are unknown; therefore, the exact $\varepsilon\alpha\beta\omega$ is unknown, etc.

Now we mention about the "evidence" with the help of pulsars [5,11,19]. Here it is not clear which of the hypotheses is tested by which of hypothesis: after all, the device of pulsars, their modes and mechanisms, their orbits and the distances to them are just assumptions; the path to them and the properties of the propagation medium are also unknown. There is no exact solution to the N-body problem in any theory, even for 3 material points. In [5], some combinations of parameters (some letters) are used, none of which can be precisely controlled. What is this test (and even more - "proof")?

3 Big Bang and Relativistic Cosmology

Theories of the evolution of the universe will forever remain hypotheses, since none of the assumptions can be verified. GTR ascribes to itself the resolution of a number of paradoxes (gravitational, photometric). Recall that the gravitational paradox consists of the following: for an infinite Universe of uniform density it is impossible to obtain certain values from the Poisson equation for the gravitational acceleration of bodies. However, what relation to reality do purely mathematical uncertainties have with conditions at infinity in a model problem? Recall also the essence of the photometric paradox. For a stationary infinite Universe without taking into account the absorption and transformation of light, the brightness of the sky should be equal to the average brightness of stars (again, many unrealistic assumptions). However, in classical physics, the possibilities of solving such paradoxes have been described (for example, using systems of different orders: Emden spheres, Charlier structures, etc.). Obviously, the Universe is not a blurred medium, and we absolutely do not know its structure as a whole in order to assert the possibility of realizing the conditions for such paradoxes (rather, on the contrary). For example, the Olbers photometric paradox is easy to understand on the basis of the ocean analogy: light is absorbed, scattered and reflected in portions and the light simply stops penetrating to a certain depth. Of course, for a rarefied Universe, such a "depth" is enormous. However, luminous stars are quite compact objects that are far from each other. As a result, only a finite number of stars contribute to the intensity of the light of the night sky (not to mention the fact that in theory it is necessary to take into account the experimental fact - the red shift).

Regarding the redshift in the spectra of astronomical objects, the situation is not fully defined. In the Universe there is a significant proportion of objects in which different parts of the spectrum have completely different displacement. Generally speaking, since the distance to distant objects is not directly determined (the calculated result is tied to certain hypotheses), then connecting it with the red shift is also a hypothesis (in which it is not known what can be tested). It should be noted that elementary scattering will contribute to the redshift and filling of the so-called relict radiation: recall that the Compton effect gives waves with $\lambda > \lambda 0$. The displacement of lines in the gravitational field was perfectly predicted even by mechanistic models from general energy considerations.

Generally speaking, the Big Bang theory raises great doubts. In addition to trivial questions: what exploded, where and when (after all, supposedly there was neither space, nor time, nor matter), the question arises: what about the conclusions of GTR about black holes (the irresistible limit of speed of light)? After all, the Universe was supposed to be a black hole at the initial moment (and not only at this moment). What about the restrictions of GTR: because now instead of such a figurative description of compression in the black hole, ubiquitous expansion is attributed to the Universe? It is interesting, probably, to compose something that cannot be verified.

Let us turn to the next principial issue. Is it a plus that the distribution and movement of matter cannot be given arbitrarily? And is this right? In the general case, this means the inconsistency of the theory, since in addition to gravitational forces, there are other forces capable of moving matter. From a practical point of view, this means that at the initial moment of time we had to specify all the distributions in the "correct for GTR" way. Then whether or not should we attribute $t0$ to the "moment of creation"? And what principles should be uniquely determined for such a choice? Knowledge is required more than any possible expectations from GTR predictions. The possibility of adding a cosmological constant to Einstein's equations is an indirect recognition of the ambiguity of the equations of general relativity and the possibility of arbitrariness.

4 Dark Matter and Dark Energy

Recall that the conclusion about the existence of the so-called "dark matter" was made **only on the basis of indirect signs** of the behavior of

astrophysical objects on the gravitational effects created by them. Contrary to modern theories, these were the following signs: the anomalously high rotational speed of the outer regions of galaxies (which does not decrease as $R^{-1/2}$, but, for example, for the Andromeda nebula remains approximately constant); estimation of the mass of galaxies from the motion of satellites of galaxies and nearby globular clusters; the stellar mass of elliptical galaxies is insufficient to hold the gas; estimation of the mass of galaxy clusters, by gravitational lensing. But maybe the theories and estimates themselves are wrong (these may be deviations from the gravitation law, as well as the presence of a rejected medium - ether)? On the one hand, it is postulated that dark matter does not interact with light, but, on the other hand, because it interacts with matter by the forces of gravity, then, contrary to the postulate, "light is emitted from where there is dark matter."

A study of 400 stars within a radius of up to 13,000 light years from the Sun did not reveal the presence of any kind of "dark matter", i.e. it is useless to look for it near the Earth (but for larger distances - these are not verifiable fantasies). Consequently, there are some problems with modern theories in extrapolation over long distances, or some parameters are incorrectly estimated for distant objects.

Along with real objects, completely mythical (the existence of which remains at the level of faith) objects were suggested as candidates for the role of "dark matter": black holes, quark stars, Q-stars, preon stars, primar black holes, Planck black holes (maximons). Relativistic physicists associate the dark matter with the invented problems of the Big Bang and relativistic cosmology. They offer fantastic particles for this role, invented to rescue some pseudoscientific theories: axions (supposedly solving the "problem" of strong CP-violation in quantum chromodynamics), mythical "supersymmetric" particles such as photino, gravitino, Higgsino, sneutrinos also fabulous topological defects of space-time, invented in the framework of the pseudo-theory of "vacuum phase transitions during the expansion of the Universe" (magnetic monopoles, cosmic strings, domain walls, textures).

If dark matter was initially in thermodynamic equilibrium with particles of the cosmic plasma, then how could the temperature drop so that this interaction would stop? For violation of sustainable equilibrium, very weighty reasons are needed (and effective mechanisms).

Regarding the hidden mass: a contradiction arises if the calculations of celestial mechanics take into account only objects visible in the optical range. However, even with the example of the Solar System, we see that besides the Sun itself (luminous), there are also planets with satellites, asteroids, meteorites, meteors, solar wind, dust, gas, etc. Thus, not all the mass in the process of evolution must concentrate in the stars. There is always a separatrix that separates the transit trajectories from trapped ones, and even for trapped trajectories, only a small fraction of the particles can get to the center, since the main movement in this case is not straight, but circular (elliptical). This means that the astrophysical part of the problem under discussion may be associated with an incorrect assessment of the real mass and its evolution, as well as with distortion of the laws obtained in the laboratory under extrapolation over long distances. The cosmological part of the problem should not be seriously discussed at all, since this is a purely hypothetical area.

We make comments on the so-called Zwicky problem (masses of clusters of galaxies). We see only ray projections onto an infinitely distant sphere. We know exactly neither the distance to objects (and, therefore, their mutual arrangement), nor their relative velocities (even the radial projection of velocity is determined with faith in some hypotheses). We don't know from where, to where and how moved (flew) these objects during billions of years and, for scanty on the cosmic scale observation time (the lifetime of observational astronomy), it is almost impossible to predict the further evolution of these objects. So, the problem is purely hypothetical.

The so-called gravitational lensing is, first of all, ordinary gas lenses (of course, related to the total mass of objects, including the mass of gas). However, density and temperature gradients along the path of the beam also play a big role. Note that the rays falling on the Earth from each such extremely distant object have a **very narrow direction** and pass their specific, almost linear path with the optical path length *sns*. However, rays that have passed through different paths can get to one point. Therefore, there is nothing surprising in obtaining several different clear images. The Lyman-alpha forest is just evidence that a variety of states of matter (in this case, hydrogen gas) can meet on the path of the beam. How at such large distances one can estimate that there is some kind of "new" (dark) matter, and even to check that it does not participate in strong interactions (and also in

electromagnetic ones) – remains a mystery. To confirm such non-participation, one must know all the conditions on the path of the beam and have a strict theory of all the states encountered!

Dark energy is invented only to "explain" the supposedly accelerating expansion of the Universe. The expansion hypothesis itself is complete nonsense, and when it was discovered that more distant objects have a greater redshift and this dependence is non-linear, it was necessary to immediately discard the expansion hypothesis and go to the theory of light redness due to scattering and attenuation of waves. Additionally, one should take into account the energy (gravitational) frequency shift when overcoming the gravitational force from the radiating object (in the direction of the beam from more strongly attracting stars and galaxies to the less attracting Earth). It is also necessary to take into account that the path from the star to the Earth will **not be straight**, but "oscillating" depending on the density and temperature gradients and the presence of gas regions. And the greater the distance to the object, the greater will be the difference between the straight line and the path length of the beam (for example, the increasing difference between the length of the sinusoid and the straight line). This is their pseudo-extension.

No crazy terms like "equation of state for dark energy" need to be invented, since only the term "equation of state of matter" has the right to exist. And it does not make sense at all to sum up the mass of real matter and the fictional (according to erroneous calculations) masses of dark matter and dark energy (?!). But the hidden mass, of course, is always there, it just has to be, because in the visible range we fix only a part of the real matter (substance).

The magnitude of the red shift is proportional to the **optical length of the path** that the light passed. The intensity of the light passing through the medium falls nonlinearly (exponentially from the real path), therefore, the estimates of the expansion of the Universe from the luminosity of supernovae Ia are incorrect.

We also note that the measurement of the microwave radiation of the Universe (the so-called "relic radiation") by the WMAP satellite proved that our Universe is flat, i.e. according to "Occam's razor" it was not worthwhile to invent a new entity – "the curvature of space-time", since Euclidean geometry is quite enough. There is also no need for general relativity and a fictional cosmological constant.

5 Gravitational Waves

We now turn to the discussion of the so-called gravitational waves. Space and time are the categories that humanity uses to describe changing (moving) matter; this is our way of knowing the world, our organization (structure) of thinking. And space-time is a completely non-existent "object", as well as its metric is only a mathematical abstraction in such a made-up pseudo-theory as GTR. On the other hand, gravity can have a field nature and material carriers; in this case, gravitational waves could well exist (having no relation to GTR). However, the speed of their distribution is not known in advance. The fact that they cannot be found for many decades is more likely evidence of their absence (we will discuss their "discovery" made to order by LIGO observatories later).

Note that the rates of convergence of the system of binary stars referred to in this connection cannot be determined for a short observation period (inaccuracies in the determination of all system parameters are too great). Seriously to say that you can fix the convergence of double stars (pulsars) at 2.5 inches per day can only be a false scientist (as if it even happens precisely in accordance with GTR). The timing of pulsars can only indicate heterogeneous processes on the pulsars themselves and in the propagation medium of the signal to the observer. None of these phenomena is in any way controlled and is not described by theory at 100%. Even for our closest star, the Sun, there is no theory that predicts all processes, for example, flares, 100% accurately. Also, the propagation of particles from this flash to the Earth is described very roughly. Why do astrophysicists claim about much more distant objects?! Generally speaking, a periodic change in the distance between the objects is observed everywhere (always, except for purely circular movements), including in the Solar System. And the effect should be more noticeable from the nearest objects. This is the first.

Secondly, the calculations made by Laplace on meticulously observing the motion of the Moon showed that the speed of propagation of gravity exceeds the speed of light by many orders of magnitude, which means that the speed of propagation of gravity waves can also be much more than c.

Third, oscillations caused by non-gravitational forces in the laboratory could have a dipole (rather than quadrupole) character, i.e. the wave energy would be greater, and the attenuation less.

Fourthly, is it really proved that the formula for the energy of the waves $E=\hbar\omega$ (or momentum $\mathbf{p}=\hbar\mathbf{k}$) stops acting for supposedly massless gravity? If not, then one should expect much more noticeable results precisely from rapidly vibrating massive objects in laboratory experiments, than from mythical interactions necessarily with a (mythical) black hole.

Fifth, any changes can be discovered only in relation to something (for example, a standard). However, if the metric itself fluctuated, the dimensions of everything, including measuring instruments, would change. As a result, it would be impossible to fix any relative change (perpendicular experimental patterns of the Michelson type interferometer, which often make false conclusions, draw attention to themselves). Thus, it is impossible in principle to detect oscillations of "space-time itself", but disturbances of a geophysical nature are easily recorded, as practice shows, i.e. GTR has nothing to do with it.

Sixth, seriously speaking about the possibility of fixing a change in the metric $10-21\sim10-23$ times can only notorious false scientists, because there are no values measured by humanity with such precision (any 1st year student would be sent to retake the theory of errors), and no statistics here can help here.

Thus, no space-time oscillations (according to GTR, these are supposedly gravitational waves) can in principle be detected independently of the "detector" device (gravitational antenna, Michelson's laser interferometer, etc.). However, what is detected - this can be explained due to real local changes inside the devices caused by changes in real physical parameters (for example, geophysical or cosmic), but not by the mythical "space-time".

The story of the alleged discovery of gravitational waves and the receipt of the Nobel Prize for the pseudo-discovery in 100 years will be considered a disgrace, worse than the times of Giordano Bruno (as there was no threat to life for those who betrayed the Truth for money and fame). What was measured exactly in this "experiment"?

1. The existence of black holes is a hypothesis;
2. the existence of gravitational waves – a hypothesis;
3. GTR is a hypothesis rather than a theory;
4. the speed of propagation of gravity coincides with the speed of light – a hypothesis;
5. the location of the disturbance source is a hypothesis;

6. distance about 1.3 billion light years away from the "source" – a hypothesis;

7. two black holes merged – hypothesis;

8. these "holes" have the mass of 36 and 29 solar masses - are two hypotheses;

9. the mass of the new "hole" and its rotation parameter are hypotheses;

10. the amount of radiated energy is a hypothesis.

Therefore, what value was not hypothetical (settlement-fitting under the theory), but measured and controlled? None! So which of these many hypotheses could be tested in this pseudo-scientific experiment? None!

It is noteworthy that the almost simultaneous observation (2016) of such perturbation and some electromagnetic signal was interpreted as the coincidence of the speed of a gravitational wave with the speed of light. However, the arrival of gamma radiation for a few seconds after some signal in 2018 is no longer interpreted as the difference in these speeds. Here is a fitting pseudoscience!

6 Conclusion

This work was devoted to a detailed analysis of GTR and related theories and hypotheses. A number of conspicuous doubtful points from the textbooks on general relativity were highlighted, including the basic physical concepts and observations underlying the general theory of relativity. The most modern experiments, allegedly confirming this theory, were critically analyzed. Doubtful moments are underlined both for the methods and for numerous consequences of general relativity, such as the Big Bang theory and relativistic cosmology. In addition, the paper discussed the problems posed by the introduction of such concepts as dark matter and dark energy and the ideas that flow from this. The recent experiments that allegedly revealed the existence of gravitational waves are analyzed in detail.

The ultimate conclusion of the article is the need to return to the classical concepts of space and time and to build a theory of gravity on this solid basis.

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HADRONIC JOURNAL 43, 79 - 119 (2020)
DOI 10.29083/HJ.43.01.2020

BINDING ENERGY OF HELIUM $^{4}_{2}$He, CARBON $^{12}_{6}$C, DEUTERIUM $^{2}_{1}$H, AND TRITIUM $^{3}_{1}$H IN VIEW OF THE SHELL-NODAL ATOMIC MODEL AND DYNAMIC MODEL OF ELEMENTARY PARTICLES

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Received February 11, 2020

Abstract

Derivation of binding energy of nucleons in deuterium, tritium, helium $^{4}_{2}He$, and carbon $^{12}_{6}C$ atoms on the basis of shell-nodal atomic model and dynamic model of elementary particles is presented in this paper. It is shown that the internal structure of nucleons at the level of constituent g-particles recalls the shell-nodal structure of silicon of the nucleon level. Calculated binding energies well agree with the binding energies estimated from mass-energy equation as the mass defect.

PACS numbers: 03.40.Kf, 03.65.GE, 11.90.+t, 12.10.-g, 12.90.+b, 13.75.Cs, 14.20.Dh, 14.40.-n, 14.60.-z, 21.10.Dr, 21.60.-n, 32.10.-f

Key words: wave equation, elementary particles, associated mass, exchange charge, binding energy, atomic structure, proton, neutron, deuterium, tritium, helium, carbon, nuclear forces, nuclear structure

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1. Introduction

Shell-Nodal Atomic Model (SNM) allows explaining the structure of matter at atomic and subatomic levels in a more logical and simple way. Different sides of the model were already published [1 - 4] or are in printing being accepted for publication [5, 6]. The model is based on particular solutions of ordinary wave equation in spherical polar coordinates and on the Dynamic Model of Elementary Particles (DM) [7].

As follows from the SNM, atoms recalls molecules if one judges on their internal structure. Their discrete points-nodes are the places of location of nucleons, at least by two per node. Nucleon nodes are located on spherical atomic shells radius of which is defined by roots of Bessel functions [8]. The main features of SNM are presented here, in introduction, very concisely. In spite of this, the reader will be able to understand in outline origination of the intra-atomic shell-nodal structure and the derivation of binding energy of atoms on the basis of the SNM without turning to references.

The wave function $\hat{\Psi}$,

$$\hat{\Psi} = \hat{R}_l(kr)\hat{Y}_{l,m}(\theta,\varphi)\hat{T}(\omega t) = \Psi_p + i\Psi_k, \qquad (1.1)$$

of the wave equation

$$\Delta\hat{\Psi} - \frac{1}{c^2}\frac{\partial^2\hat{\Psi}}{\partial t^2} = 0, \quad \text{or} \qquad \Delta\hat{\Psi} + k^2\hat{\Psi} = 0, \qquad (1.2)$$

contains spherical harmonics

$$\hat{Y}_{l,m}(\theta,\varphi) = \Theta_{l,m}(\theta)\hat{\Phi}_m(\varphi) = C_{l.m}P_{l.m}(\cos\theta)C_m \exp[\pm i(m\varphi + \alpha)], \qquad (1.3)$$

where $C_{l,m}$ and C_m are coefficients depending on the normalizing conditions, $P_{l,m}(\cos\theta)$ are Legendre adjoined functions, $\Phi_m(\varphi)$ are azimuthal functions, α is an initial phase of the azimuthal state,

$$k = \frac{2\pi}{\lambda} = \frac{\omega}{c} \qquad (1.4)$$

is the wave number.

The difference between solutions of ordinary wave equation (1.2) and the Schrödinger's wave equation [9] is defined by the difference in radial

equations (because of the different wave numbers k), which yields the different radial solutions $\hat{R}_l(kr)$. Schrödinger's radial equation and its solutions are analysed in detail in [10, 11].

At integer values of the wave number m, the particular solution of the wave equation (1.2) has the standard form. If we present the number m in the form $m = \frac{1}{2}2s$, where $s \in N$, we arrive at

$$\hat{\psi} = A_l \hat{R}_l(\rho)\Theta_{l,s}(\theta)e^{\pm is\varphi} = A_l\sqrt{\pi/2\rho}H^{\pm}_{l+1/2}(\rho)\Theta_{l,s}(\theta)e^{\pm is\varphi} \qquad (1.5)$$

or

$$\hat{\psi} = A_l\sqrt{\pi/2\rho}(J_{l+1/2}(\rho) \pm iY_{l+1/2}(\rho))\Theta_{l,s}(\theta)e^{\pm is\varphi}, \qquad (1.6)$$

where A_l is the constant factor; $\rho = kr$; $H^{\pm}_{l+1/2}(\rho)$, $J_{l+1/2}(\rho)$ and $Y_{l+1/2}(\rho)$ (or $N_{l+1/2}(\rho)$) are the Hankel, Bessel and Neumann functions, correspondingly.

The form of the function (1.6) uniquely shows that it describes the kinematic structure of *standing spherical waves* in wave physical space. Thus the solution (1.6) yields the spatial geometry of disposition of specific points (nodes and antinodes) in which the wave $\hat{\Psi}$ function takes the zero and extremal values. With this, polar-azimuthal functions, potential and kinetic, define the *angular spatial coordinates*, respectively, of nodes and antinodes of the standing spherical waves.

Two terms in (1.6) are the potential and kinetic *spatial* constituents of the $\hat{\Psi}$-function; they have the following form

$$\hat{\psi}_p = Ac_l(\rho)/\rho = A\sqrt{\pi/2\rho}J_{l+1/2}(\rho)\Theta_{l,m}(\theta)e^{\pm im\varphi}, \qquad (1.7)$$

$$\hat{\psi}_k = \pm As_l(\rho)/\rho = \pm A\sqrt{\pi/2\rho}Y_{l+1/2}(\rho)\Theta_{l,m}(\theta)e^{\pm im\varphi}. \qquad (1.8)$$

The half-integer solutions of (1.2), at $l = m = (1/2)s$, have the form

$$\hat{\psi} = A\hat{R}_s(\rho)\Theta_s(\theta)e^{\pm i\frac{s}{2}\varphi}, \qquad (1.9)$$

where

$$\hat{R}_s(\rho) = \sqrt{\pi/2\rho} H^{\pm}_{\frac{s}{2}+\frac{1}{2}}(\rho), \tag{1.10}$$

$$\Theta_s(\theta) e^{\pm i\frac{s}{2}\varphi} = C_s \sin^{\frac{s}{2}}\theta(\cos\frac{s}{2}\varphi \pm i\sin\frac{s}{2}\varphi). \tag{1.11}$$

All spatial components are determined with the accuracy of a constant factor A, imposed by boundary conditions, which have no influence on the peculiarity of distribution of the *nodes* on radial spheres. The superposition of even and odd solutions defines the *even-odd solutions*. Odd solutions describe the nodes, lying in the equatorial plane of atomic space. In this plane there are also solutions in the form of *rings* in space (graphically shown further) separated by radial unstable shells.

$\hat{\Psi}$-Function represents any parameter of the *wave* field such as, for example, potential-kinetic displacement, potential-kinetic speed, physical potential-kinetic probability, *etc.*

The radial component $\hat{R}_l(kr)$ of the wave function $\hat{\Psi}$ (1.1) describes the radial field of displacements of the wave parameter, which the $\hat{\Psi}$-function represents in the wave equation (the density of potential-kinetic phase probability, in the work [12]), the polar component $\Theta_{l,m}(\theta)$ describes the polar displacements, and $\hat{\Phi}_m(\varphi)$ describes the azimuth displacements.

The potential solutions define the coordinates of rest, whereas the conjugate kinetic solutions define the coordinates of maxima of motion. Thus, the potential solutions give us the spatial coordinates of equilibrium domains (nodes of standing spherical waves) in the wave atomic space.
Thus, we should distinguish two solutions, potential and kinetic, do not mixing them [13]. Rest and motion (nodes and antinodes) are the two *qualitatively different* states. Kinetic harmonics are the same, in form, as potential harmonics, but they are displaced in space in the radial direction and turned in the azimuthal direction, around the z-axis, with respect to potential harmonics (just like $\cos m\varphi$ with respect to $\sin m\varphi$ in (1.3)) so that the kinetic extrema are between the corresponding potential extrema (as alternated nodes and antinodes in standing waves).

The form of the radial equation and its solutions $\hat{R}_l(kr)$ depend on the concrete problem, which imposes the definite requirements on the wave number k. However, for any model of an object of study, the radial solutions define the characteristic spheres of extrema and zeros of the radial function.

For a variety of problems, it is sufficient to know at most that such characteristic spheres exist.

Evidently, the polar-azimuth equation is common (universal) for all spherical objects if they are described by the general wave equation (1.2).

Radial solutions $\hat{R}_l(kr)$ entered in (1.5) are defined by roots of Bessel functions [8]. They give the equilibrium spherical shells of standing spherical waves in the wave field of potential and kinetic displacements.

Polar-azimuthal functions of (1.5) define polar-azimuthal coordinates of *nodes and antinodes of standing spherical waves*, located on these shells.

Polar components $\Theta_{l,m}(\theta)$ of the $\hat{\Psi}$-function (1.1) define characteristic parallels of extrema (principal and collateral) and zeros on radial spheres (shells). Azimuthal components $\hat{\Phi}_m(\varphi)$ define characteristic meridians of extrema and zeros. Potential and kinetic polar-azimuthal functions $\hat{Y}_{l,m}(\theta,\varphi)$ select together the distinctive coordinates of extrema and zeros on the radial shells.

The geometry of characteristic states on radial shells is expressed by extrema and zeros of the polar-azimuthal components of the $\hat{\Psi}$-function. The *potential* solutions of the $\hat{\Psi}$-function (for $l = 0, 1, 2, 3, 4, 5$) are depicted graphically in Fig. 1.1 for a constant value of the radial coordinate r. In this figure, with an example for $l = 5$ and $m = \pm 2$, it is also showed how the presented discrete (nodal) structure of the three dimensional wave space is obtained from the aforementioned solutions for the different wave numbers l and m.

The graphs of the solutions indicate that there are *principle* (designated in Fig. 1.1 by shaded points) and *collateral* (designated by the smaller unnumbered hollow points) extrema, which determine, correspondingly, stable and metastable states of probabilistic events.

Principal *potential* polar-azimuthal nodes are numbered in Fig. 1.1 by ordinal numbers. The principal polar-azimuth extrema (potential and kinetic, $m \neq 0$) mainly define the geometry of radial shells of atomic space, whereas collateral extrema ($m \neq 0$) play the secondary role. Both principal and collateral extrema are points-nodes of the steady-state discrete geometry of the wave field of matter-space-time of atoms.

As it turned out, the shell-nodal structure, presented in Fig. 1.1, is reminiscent of *spherical resonant cavities* [14] (described by Bessel functions as well) having internal oscillating electric and magnetic mode fields. And

what is more, as appears from the comprehensive analysis, all types of *elementary crystal lattices represent*, in essence, elementary *nodal structure of standing waves* in a limited three-dimensional wave physical space [1, 6].

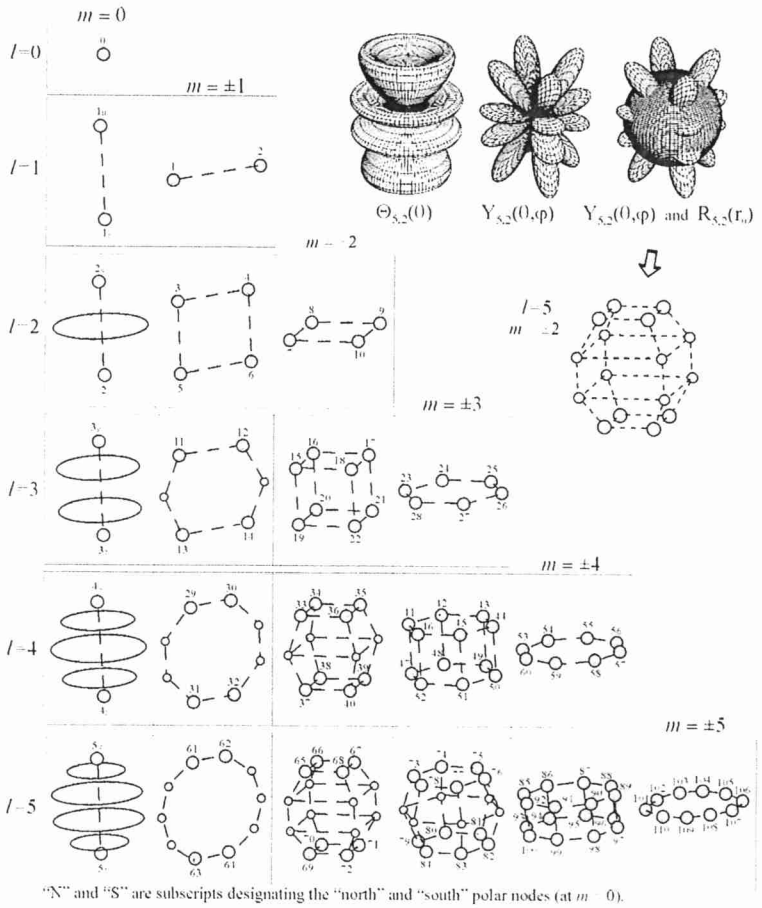


Fig. 1.1. Spatial solutions $\psi_{l,m}(\rho,\theta,\varphi)_p = C_\psi R_l(\rho)\Theta_{l,m}(\theta)Cos m\varphi$ (for $r = const$) of the wave equation (1.2) for *spherical standing waves* presented in the form indicating the space distribution of *potential* extrema-nodes (discrete elements of the shell-nodal structure of atoms); numbers 1, 2, 3, …, 110 are the ordinal numbers of the principal potential polar-azimuth nodes coinciding with atomic numbers of the elements Z [1].

Thus, the spatial shell-nodal structure presented in Fig. 1.1 uniquely determines the structure of matter at the atomic and molecular levels, in particular, the intra-atomic structure and the structure of crystals.

The quasi-similarity of the geometry of external shells, for the same quantum number m and different quantum numbers l, clearly seen from Fig. 1.1, reveals the nature of Mendeleev' Periodic Law [5, 15]. A great body of other important consequences, originated from the above solutions, relates to the new data concerning the atomic structure, periodicity, symmetries, the nature and structure of isotopes [16], *etc.* These and other relevant data one can find in the reference works of the author.

2. The shell-nodal structure of helium ${}^{4}_{2}He$, and carbon ${}^{12}_{6}C$

The completely realized polar-azimuthal n-th potential shell (with potential nodes) is defined, in accordance with (1.2), by the function

$$\Psi_{l,m}(\rho_{l,n},\theta,\varphi)_p = C_\Psi R_l(\rho_{l,n})\Theta_{l,m}(\theta)\cos(m\varphi+\alpha), \qquad (2.1)$$

where $\rho_{l,n}$ is the relative radius of the n-th external radial shell. The geometry of angular disposition of nodes is determined by polar-azimuthal functions $\Theta_{l,m}(\theta)\cos(m\varphi+\alpha)$ of (2.1). The latter and their sections are presented in Fig. 2.1 for hydrogen, helium, and carbon atoms. In the case of carbon atom, two configurations of functions, $\Theta_{1,1}(\theta)\cos\varphi$ and $\Theta_{1,1}(\theta)\cos(\varphi+\pi/2)$, different by initial azimuthal phases ($\alpha = 0$ and $\alpha = \pi/2$), are shown in Fig. 2.1. The octahedral structure ($\alpha = \pi/2$) is realized in the diamond structure of carbon.

The nodal structure of ${}^{4}_{2}He$ and ${}^{12}_{6}C$, originated from (2.1), is conditionally shown in Fig. 2.2. The carbon's nodal structure is depicted with the plane disposition of its six principal polar-azimuth nodes ($\alpha = 0$). All principal polar-azimuthal nodes in the stable isotopes, which are presented in this figure, are filled with paired nucleons - say H-atoms (to which we refer the hydrogen atoms, protons and neutrons). Polar nodes are situated at the polar azis z, forming something like "spinal" of atoms.

The nodal structure of carbon isotope ${}^{12}_{6}C$ and its polar-azimuth functions are shown also in Fig. 2.3. The carbon atom has the central empty node ($m = 0$, $l = 0$) and four spherical shells: two shells ($m = 0$, $l = 1, 2$) with four empty

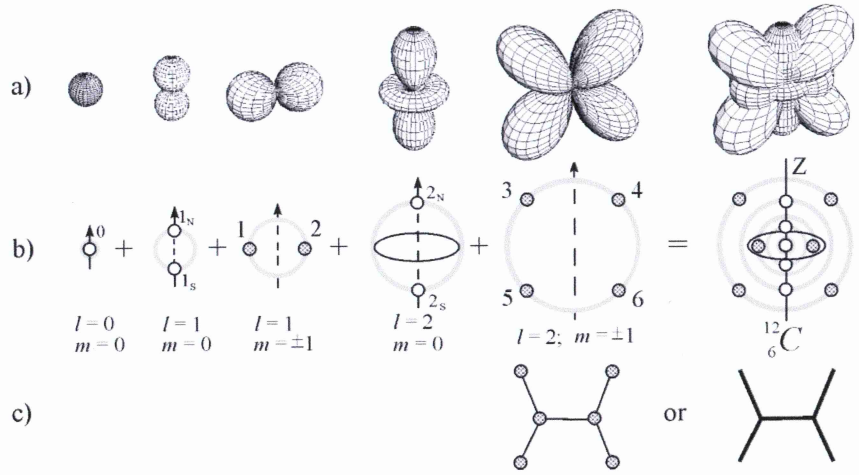


Fig. 2.3. Plots of potential polar-azimuth functions $\Theta_{l,m}(\theta)\mathrm{Cos}m\varphi$ ($l=0,1,2$; $m=0,\pm1$) (a), their extremal points on radial extremal shells $R_l(\rho)$ (b), and the symbolic designation of carbon $_6$C (c).

Six potential polar-azimuth nodes (at $m=\pm1$), completed every by two H-atoms, lie in one plane: two potential nodes are in the inner shell (l = 1) and the four ones are in the outer shell (l = 2). Six empty kinetic nodes (not shown here) lie in a perpendicular plane with respect to the plane of disposition of potential nodes, on kinetic radial shells.

Hydrogen is mainly in coherent states in Nature, in particular, in the form of coupled atoms – hydrogen molecules H_2. Paired H-atoms, filling polar-azimuth nodes, apparently provide for the stable state of atomic shells. The *condition of coupling*, observed in nature, is inherent not only for H-atoms in nodes of individual atoms, but probably also for individual atoms themselves in solids, liquids, and molecules built on their basis.

The distance r between nodes is defined by roots of Bessel functions $z_{n,m}=kr$, as follows from solutions (1.6) of the wave equation (1.2).

The derivation of binding energy of nucleons, located in nodes of atoms, rests on the Law of Universal Exchange, which originates from the Dynamic Model of Elementary Particles (DM) [7]. Therefore, we will recall now the main features of the DM and show the formula of exchange used for calculations of binding energies here.

potential-kinetic polar nodes (situated along the z-axis) and one *ring*, two shells ($m=\pm1; l=1,2$) with six completed *potential polar-azimuth nodes* and six empty *kinetic polar-azimuth nodes* (the lasts are shown neither in Fig. 1.1 nor in other figures).

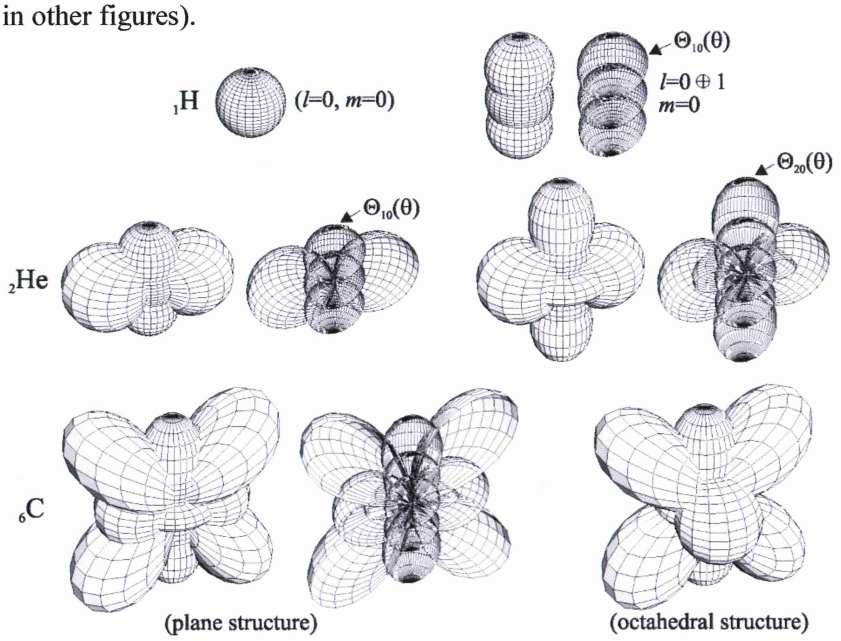
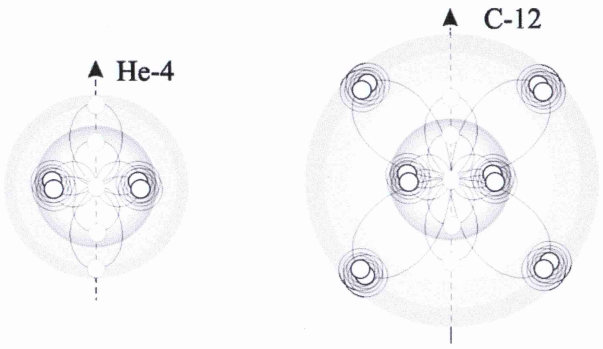


Fig. 2.1. The structure of potential polar-azimuthal functions (integer solutions) for hydrogen $_1H$, helium $_2He$, and carbon $_6C$.



Fi.2. 2. The nodal structure of helium ^4_2He and carbon $^{12}_6C$.

3. Dynamic model of elementary particles; the law of central exchange

We regard elementary particles as dynamic spherical formations of a complicated internal structure being in dynamic equilibrium with environment through the wave process of the definite frequency ω_e characteristic for the atomic and subatomic levels [7]. Longitudinal oscillations of their spherical wave shells in the radial direction provide an interaction of the particles with other objects and the ambient field of matter-space-time. The logical triad: *matter-space-time* expresses an indissoluble bond of matter, space, and time (incessant wave motion).

The wave shell, or in another words, the characteristic sphere of an elementary particle restricts the main part of the particle from its field part merging gradually with the ambient field of matter-space-time. The main part (core) is the *basis* of the particle, whereas the field part represents its *superstructure*. Such a model interprets an elementary particle as a particular pulsing physical point (like a micropulsar) of an arbitrary level of matter-space-time, restricted by the characteristic wave sphere and being in rest in the field-space.

The existence and interactions of the particles are, in essence, a continuous process of wave *exchange* of matter-space-time. The wider (and, hence, truer) notion *exchange* is thus more correct because it reflects behavior of elementary particles in their dynamic equilibrium with the ambient field, at rest and motion, and interactions with other objects (and particles themselves). In other words, the notion *exchange* is more appropriate from the point of view of the physics of the complex behavior of elementary particles viewed as dynamic micro-objects belonging to one of the interrelated levels of the many-level Universe.

The ratio of mass dm and volume dV of elementary particles defines their *absolute-relative density* ε:

$$\varepsilon = dm / dV = \varepsilon_0 \varepsilon_r, \qquad (3.1)$$

where $\varepsilon_0 = 1\, g \cdot cm^{-3}$ is the *absolute unit density*, and ε_r is the *relative density*.

Masses of all dynamic formations (micro-particles) in the Universe, according to the DM, have *associated field character* with respect to the deeper level of the field of matter-space-time; therefore, their own (proper, rest)

masses do not exist. Associated mass, or briefly the mass of the particle is defined from the formula

$$m = \frac{4\pi r^3 \varepsilon_0 \varepsilon_r}{1 + k_e^2 r^2}, \tag{3.2}$$

where r is the radius of the wave shell;

$$k_e = 2\pi / \lambda = \omega_e / c \tag{3.3}$$

is the wave number corresponding to the *fundamental frequencies* ω_e of the field of exchange, which is characteristic for the atomic and subatomic levels of the Universe.

The *speed of wave exchange* is presented in the form

$$\hat{\upsilon} = \upsilon(kr) e^{i\omega t}, \tag{3.4}$$

The volumetric rate of mass exchange of the particles with environment called the *exchange charge*, or merely the charge, is defined as

$$\hat{Q} = d\hat{m} / dt = S\hat{\upsilon}\varepsilon, \tag{3.5}$$

where S is the area of a closed surface separating the space of an elementary particles from the surrounding field of matter-space-time, υ is the speed of wave exchange (interaction) at the separating surface. Strictly speaking, the exchange charge is the measure of the rate of exchange of matter-space-time, or briefly the *power of mass exchange*. In this wider sense, the area of exchange S does not necessary concern the closed surface. The symbol "^" expresses the contradictory (or complex) *potential-kinetic* character of physical space-fields [17, 18].

Derivations carried out in [1, 7] have shown that the charge of exchange $\hat{Q}$ has the active-reactive character. It is defined as

$$\hat{Q} = \frac{4\pi r^3 \varepsilon_0 \varepsilon_r}{1 + k_e^2 r^2} (k_e r \omega_e + i\omega_e) = Q_a + iQ_r, \tag{3.6}$$

where

$$Q_a = \frac{4\pi r^3 \varepsilon_0 \varepsilon_r}{1 + k_e^2 r^2} kr\omega \qquad \text{and} \qquad Q_r = \frac{4\pi r^3 \varepsilon_0 \varepsilon_r}{1 + k_e^2 r^2} \omega \tag{3.7}$$

are *active* and *reactive charges*, correspondingly.

The active component Q_a defines the dispersion during exchange, which in a steady-state process of exchange is compensated by the inflow of motion and matter from the deeper levels of space.

We see that the reactive component of charge Q_r, called in contemporary physics the "*electric*" charge (further for brevity, the *charge of exchange* Q) is connected with the associated mass m (3.2) by the relation

$$Q = m\omega_e . \qquad (3.8)$$

From (3.8) it follows that the *dimensionality* of the exchange charge is $g \cdot s^{-1}$. Thus, the DM reveals the physical meaning of the electric charge. The exchange ("electric") charge is the measure of the *rate of exchange* of matter-space-time, or briefly the power of mass exchange; its alternative value changes with the fundamental frequency ω_e.

The derivation carried out first in [19] (details one can find in [7], see also [20]) leads to the following formula of correspondence between exchange charge Q and Coulomb charge q_C:

$$Q = q_C \sqrt{4\pi\varepsilon_0} . \qquad (3.9)$$

We recall, here and further in the DM, $\varepsilon_0 = 1\, g \cdot cm^{-3}$ is the absolute unit density. Hence, the *exchange* (*reactive*) *charge* of an electron at the level of the fundamental frequency ω_e is

$$e = e_C \sqrt{4\pi\varepsilon_0} = 1.702691627 \cdot 10^{-9}\ g \cdot s^{-1}, \qquad (3.10)$$

where $e_C = 4.803204401 \cdot 10^{-10}\ CGSE_q$ is the Coulomb charge of an electron in CGSE system of units. The dimensionality of the unit $1\mathrm{CGSE}_q$ is actually expressed by fractional powers of absolute units of matter and space of CGS systems, $g^{1/2} \cdot cm^{3/2} \cdot s^{-1}$, that has no physical meaning. An introduction of the SI unit of the electric charge, 1 Coulomb, did not change the situation, because the dimensionality of the charge is actually, as before, expressed by fractional powers of the units of matter and space, $kg^{1/2} \cdot m^{3/2} \cdot s^{-1}$ [21].

The exchange charge of the value (3.10) (electron charge) represents an *elementary quantum of the rate of mass exchange*. On the basis of (3.8) and (3.10), knowing the mass of the electron m_e, we found the *fundamental frequency of the wave field of exchange* at the *subatomic level*

$$\omega_e = e/m_e = 1.869162505 \cdot 10^{18}\ s^{-1}. \qquad (3.11)$$

It is the frequency of the field called in modern physics "*electrostatic*". Note in this connection that there are no "static" fields in the Universe where all is in incessant wave motion.

The radius of wave shells of particles r is derived from the formula of mass (3.2), where $\varepsilon_r = 1$, $k_e = 1/\lambda\!\!\!^{-}_e$, with

$$\lambda\!\!\!^{-}_e = c/\omega_e = 1.603886538 \cdot 10^{-8}\ cm \qquad (3.12)$$

Thus, the notion *rest mass* of elementary particles is not valid of principle for the DM. Accordingly, one could conclude that the rest mass of elementary particles does not exist. The *associated nature of mass*, as the field mass of the central wave exchange, naturally originates from this model. Moreover, in the DM, particles are boundless in size. Characteristic spheres (wave shells) of the particles restrict only their inner and external spaces. According to the definition, geometrical space (spherical volume) of an elementary particle, restricted by its wave spherical shell, is the external world of the particle.

From the above it follows that the physical field-space of the Universe represents by itself an infinite series of spaces embedded in each other [recalling a set of nesting dolls, or infinite functional series $f(x) = \sum_{k=1}^{\infty} u_k(x)$]. This series of spaces expresses the fundamental concept of natural philosophy concerning the infinite divisibility of matter. Every level of space is the basis level for the nearest above-situated level and, simultaneously, it is the level of superstructure for the nearest below-situated level. This means that above-situated field-spaces are formed on the basis of below-lying field-spaces. Accordingly, there is no meaning to the concept of "very last elementary particle" in the common classical sense of this phrase.

As follows from the DM [7], the law of central exchange has the form

$$F = \omega^2 \frac{m_1 m_2}{4\pi\varepsilon_0 r^2}, \qquad (3.13)$$

where ω is the fundamental frequency of exchange, m_1 and m_2 are associated masses defined by (3.2), $\varepsilon_0 = 1\,g \cdot cm^{-3}$ is the absolute unit density. This law lies at the foundation of nature. If $\omega = \omega_e$ (3.11), this law describes exchange (interactions) at the atomic and subatomic levels:

$$F_e = \omega_e^2 \frac{m_1 m_2}{4\pi\varepsilon_0 r^2}. \qquad (3.14)$$

A particular case of the law (3.13) is the law of universal gravitation, which we present in the form

$$F_g = \omega_g^2 \frac{m_1 m_2}{4\pi\varepsilon_0 r^2}, \qquad (3.15)$$

where ω_g is the fundamental frequency at the gravitational (mega) level of the Universe, *i.e.*, the fundamental gravitational frequency. Its magnitude, defined on the basis knowing the value of the gravitational constant $G = 6.6742 \cdot 10^{-8}\, cm^3 \cdot g^{-1} \cdot s^{-2}$, is equal to

$$\omega_g = \sqrt{4\pi\varepsilon_0 G} = 9.1581 \cdot 10^{-4}\, s^{-1}. \qquad (3.16)$$

The existence of the *gravitational frequency* ω_g and, hence, the corresponding *gravitational radius* of elementary particles $\lambda\!\!\!^{-}_g = c/\omega_g = 327.35\, Mkm$ shows the indissoluble bond of micro- and mega-objects of the Universe in the unit complex of the Infinitely Small and Infinitely Big, as the coexisting polar oppositions.

According to the DM, and the law of the universal exchange (3.14), the energy of exchange (interaction) of particles is defined, at atomic and subatomic levels, by the formula

$$E = \omega_e^2 \frac{m_1 m_2}{8\pi\varepsilon_0 r}, \qquad (3.17)$$

where $\omega_e m_1 = q_1$ and $\omega_e m_2 = q_1$ are exchange charges of interacting particles. We will use juct this formula at the derivation of internodal binding energies of nucleons in atoms.

4. The binding energy of helium ^4_2He

The binding energy of nucleons in atoms is attributed to three causes and consists of:

(1) the binding energy of paired nucleons in nodes, *i.e.*, in essence, it is the energy of deuterons;

(2) the binding energy of nucleon nodes with atomic shells to which these nodes belong; and
(3) the energy of internodal exchange (interaction) of nucleons.

The derivation of the **first** constituent of the binding energy on the basis of the DM and SNM with use of (3.17), we will consider latter at the derivation of the binding energy of deuterium. Here, in order to take into account the binding energy of deuterium, we will use the value obtained from the mass defect formula:

$$\Delta E = c^2 \Delta m \tag{4.1}$$

A deuteron is the nucleus of a deuterium atom, and consists of one proton and one neutron. The mass of the constituents is

$$m_p + m_n = 1.007276 + 1.008665 = 2.015941 amu\,. \tag{4.2}$$

The atomic mass of the deuteron D (^{2}H) is 2.013553 *amu*; hence, the mass difference is $\Delta m = 0.002388 amu$. Thus, according to (4.1), a deuteron's binding energy is

$$E_D = c^2 \Delta m = 2.224 MeV\,. \tag{4.3}$$

The **second** constituent of the binding energy is defined from the following conditions. In a *spherical atomic field*, radial amplitudes of oscillations of *H*-units in nodes of the *n*-th atomic shell are determined by the expression

$$\hat{A}_s = A\hat{e}_l(kr)/kr \tag{4.4}$$

originated from solutions of (1.2) for the radial function $\hat{R}_l(kr)$ [1]. Then, the energy of oscillations takes the form:

$$E_s = \frac{m_p \omega^2 A_s^2}{2} = \frac{1}{2} h\nu = \frac{m_p \omega^2}{2}\left(\frac{A}{kr}\right)^2 e_l^2(kr) = \frac{m_p c^2 A^2}{2r^2} e_l^2(kr), \tag{4.5}$$

where m_p is the mass of *H*-unit. Obviously, that

$$h = 2\pi m_p \upsilon_s A_s = 2\pi m_p \omega \left(\frac{A}{kr}\right)^2 e_l^2(kr) = \frac{2\pi m_p c A^2}{kr} e_l^2(kr), \tag{4.6}$$

where

$$e_l(kr) = |\hat{e}_l(kr)| = \sqrt{\frac{\pi kr}{2}\left(J^2_{l+½}(kr) + Y^2_{l+½}(kr)\right)}, \qquad (4.7)$$

$J_{l+½}(kr)$ and $Y_{l+½}(kr)$ are the Bessel functions.

At $n = 0$, in the wave zone ($kr = 1$), we have

$$h = 2\pi m_p c A^2 / r_0 . \qquad (4.8)$$

From this, we define the constant A:

$$A = \sqrt{\frac{hr_0}{2\pi m_p c}} . \qquad (4.9)$$

In the wave zone, $r_0 = ƛ_e$, then assuming that the radial action for the mass m_p is $h = 2\pi m_p \upsilon ƛ_e$, we arrive at

$$A = \sqrt{\frac{hr_0}{2\pi m_p c}} = ƛ_e \sqrt{\frac{\upsilon}{c}} . \qquad (4.10)$$

If one assumes further the speed υ to be equal to the Bohr speed, the constant A takes the value of

$$A = 1.370113189 \cdot 10^{-9}\, cm . \qquad (4.11)$$

Accepted suppositions lead to the following energy of the H-unit in a node, at $m_p = m_u$ (atomic mass unit):

$$E_s = \frac{m_u \omega^2 A_s^2}{2} = \frac{m_u \omega^2 A^2}{2(kr)^2} e_l^2(kr) = \frac{\pi\left(J^2_{l+½}(kr) + Y^2_{l+½}(kr)\right)}{2kr} \frac{m_u \omega^2 A^2}{2} . \qquad (4.12)$$

At the level of the fundamental frequency ω_e, we have

$$w_u = \frac{m_u \omega_e^2 A^2}{2} = 3398.72\ keV \qquad (4.13)$$

and

$$E_s = \frac{m_u \omega_e^2 A_s^2}{2} = \frac{w_u}{z_{l,s}^2} e_l^2(z_{l,s}), \qquad (4.14)$$

where $z_{l,s} = kr$ is the root of Bessel functions [8] .

The binding energy (4.14) is only an estimation of the bond of an atomic shell with the *n*-node, because it was obtained on the basis of a series of suppositions, which should be regarded as preliminary axioms. A transition from one *n*-shell into another is defined by the energy of transition:

$$\Delta E_s = w_u \left(\frac{e_p^2(z_{p,m})}{z_{p,m}^2} - \frac{e_q^2(z_{q,n})}{z_{q,n}^2} \right). \qquad (4.15)$$

The root $z_{l,s} = y_{0,1} = 0.89357697$ defines the equilibrium distance

$$r_{He} = y_{0,1} \lambda\!\!\!^{-}_e = 1.433196073 \cdot 10^{-8}\, cm \qquad (4.16)$$

between two polar-azimuthal nodes on the external atomic shell of helium ${}_2^4He$ (see Fig. 2.2). Hence, according to (4.14), the binding energy of a nucleon node with the atomic shell in helium is

$$E_{shell} = \frac{w_u}{y_{0,1}^2} e_0^2(y_{0,1}) = 3.92109\, MeV\,. \qquad (4.17)$$

The **third** constituent of the binding energy of helium, the energy of internodal exchange, is determined by the formula (3.17). The *quantum* of internodal nucleon exchange, $q = m\omega_e$, under formation of internodal bonds at the nucleon ("nuclear") level, is the *nucleon's exchange charge*. It means that the *exchange charge* of two such quanta maximum, by one per every node (proton's or neutron's exchange charge), can take part in the internodal exchange. Then, at $r = r_{He}$ (4.16), $\omega_e = 1.869162505 \cdot 10^{18}\, s^{-1}$, and the proton's exchange charge $q_p = m_p \omega_e$, where

$$m_1 = m_2 = m_p = 1.67262171 \cdot 10^{-24}\, g \qquad (4.18)$$

is the associated mass of a proton, we have the energy of exchange (per two pairs of nucleons)

$$E_{exch} = \omega_e^2 \frac{m_p^2}{8\pi\varepsilon_0 r_{He}} = 16.91883553\,MeV\,. \qquad (4.19)$$

Hence, the exchange binding energy per nucleon is

$$E_{exch/n} = E_{exch}/4 = 4.229708883\,MeV\,, \qquad (4.19a)$$

and per single internodal nucleon bond (pair),

$$E_{exch/b} = E_{exch}/2 = 8.459417765\,MeV\,. \qquad (4.19b)$$

For estimation, we take into account the double bond between nodes in helium-4 realized by the elementary quantum of internodal nucleon exchange. It means that two pairs of nucleons participate in the internodal bond, so that the whole value (4.19) must be taken in this case.

As a result, the binding energy of helium atom ${}_2^4He$ obtained as the sum of three constituents: (4.3), (4.17), and (4.19), is defined by the expression

$$E_{He,atom} = 2E_D + 2E_{shell} + E_{exch} \qquad (4.20)$$

and equal to

$$E_{He,atom} = 2\cdot 2.224 + 2\cdot 3.92109 + 16.91883553 = 29.209\,MeV. \qquad (4.21)$$

In the shell-nodal atomic model there is not such a notion as a nucleus. The value (4.20) was obtained for the helium atom as a whole independently of an existence of two electrons in the helium atom. The contribution of two electrons in the binding energy is insignificant. The energies of electron bond with proton (ionization energies) and of interelectron exchange (interaction) are very small in comparison with the energy of internucleon exchange. Actually, according to the formula of exchange (3.17), we have

$$E_{e-exch} = \omega_e^2 \frac{m_e^2}{8\pi\varepsilon_0 r_{He}} \approx 5.24\,eV\,, \qquad (4.22)$$

where $\omega_e m_e = e = 1.702691627\cdot 10^{-9}\ g\cdot s^{-1}$ is the exchange charge of an electron. The energy obtained naturally defines the difference between the two energies of ionization of the helium atom:

$$E_{e-bond} = E_{ion}^{(2)} - E_{ion}^{(1)} = (54.42 - 49.18)\,eV = 5.24\,eV\,. \qquad (4.23)$$

Thus, finally, at the subtraction of energy of two electrons $2E_e = 2m_e c^2$ from (4.21), the binding energy of helium ion ${}_2^4He^{-2}$ ("nucleus") is

$$E_{He,ion} = E_{He,atom} - 2E_e = 29.209 - 2 \cdot 0.510998902 \approx 28.187\,MeV\,. \quad (4.24)$$

If we substitute the neutron's mass $m_n = 1.67492728 \cdot 10^{-24}\,g$ in place of m_p in (4.18), we will arrive at

$$E_{He,ion} \approx 28.23\,MeV\,. \qquad (4.25)$$

Resulting magnitudes, (4.24) and (4.25), almost coincides with the binding energy

$$\Delta E_{He} = c^2 \Delta m \approx 28.3\,MeV \qquad (4.26)$$

obtained for the helium nucleus on the basis of the formula on the mass defect.

5. The binding energy of carbon ${}_6^{12}C$

Basing on solutions of Eq. (1.2), we must take into account only those shortest internodal bonds in the carbon atom ${}_6^{12}C$ which distinguish by the shortest distances between wave shells of internodal nucleons. Angular directions of such bonds are in more or less extent conditioned by the space geometry of polar-azimuthal functions (see Fig. 2.1, 2.2, and 2.3). Only along these directions shown in Fig. 5.1a the chemical bonds between nucleon nodes of different atoms are realized at formation of molecules and crystals [4].

Five internodal bonds responsible for the binding energy in the carbon atom have the same length $r_1 \approx 2.7 r_0$ (where r_0 is the Bohr radius), defined by the root of Bessel functions $y_{0,1}$ (as in the case of the helium atom):

$$y_{0,1} = 0.89357697, \qquad r_1 = y_{0,1} \lambda\!\!\!^{-}_e = 1.433196073 \cdot 10^{-8}\,cm$$

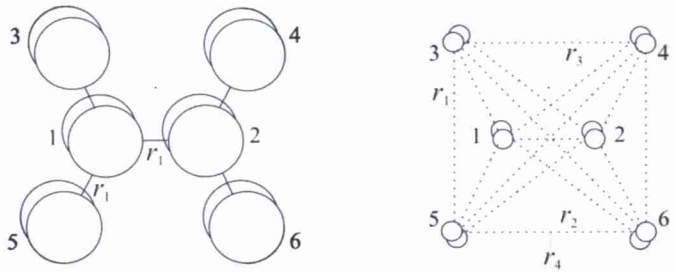


Fig. 5.1. The geometry of internodal nucleon ("nuclear") bonds in the carbon ${}^{12}_{6}C$ atom (a) and characteristic internodal distances (b) (between their centers) defined by the roots of Bessel functions.

All other characteristic internodal distances in the carbon atom, shown in Fig. 5.1b, are not arbitrary as well. They are defined, as r_1, by the roots of Bessel functions. This is justified by regularities of wave processes, described by the Bessel functions, that influences the strictly definite structure of the material spaces at all level:

$$y_{1/2,1} = 1.57079633 \qquad r_2 = y_{1/2,1}\lambda\!\!\!^{-}_e = 2.519379088 \cdot 10^{-8}\, cm$$

$$j_{0,1} = 2.40482556 \qquad r_3 = j_{0,1}\lambda\!\!\!^{-}_e = 3.857067342 \cdot 10^{-8}\, cm \quad (5.1)$$

$$j'_{1,1} = 1.84118378 \qquad r_4 = j'_{1,1}\lambda\!\!\!^{-}_e = 2.953049879 \cdot 10^{-8}\, cm$$

As in the case of the helium atom, three constituents of the binding energy must be taken into account. The first one, considering the coupling of two nucleons in a node in the form of deuteron, gives us the deuteron's binding energy E_D of 2.224 *MeV* (4.3) per node.

The second constituent of the binding energy takes into account the bond of a node with the atomic shell where this node is located. According to (4.14) and (4.15), for the 1st and 2nd nodes (Fig. 5.1) situated at the internal atomic shell (the shell of helium), we have $z_{l,m} = y_{0,1}$ and $E_{\text{int},shell} = 3.92109\, MeV$ (4.17).

Transitions of nucleons from the internal shell to the external shell, where four nodes are located, are defined by the formula of energy of transitions (4.15). For $z_{p,m} = y_{0,1}$ and $z_{q,n} = y_{1/2,1}$, we have $E_{trans} = 2.54363\,MeV$. The binding energy for every of four nodes of external shell is

$$E_{ext,shell} = \frac{w_u}{y_{1/2,1}^2} e_{1/2}^2(y_{1/2,1}) = 1.37745\,MeV. \qquad (5.2)$$

The third constituent of the binding energy of the carbon atom ${}^{12}_{6}C$, the energy of internodal exchange, is determined by the formula (3.17). According to the latter, an elementary binding energy, caused by exchange interaction between two nodes a distance r_1 apart, is

$$E_{exch} = \omega_e^2 \frac{m_p^2}{8\pi\varepsilon_0 r_1} = 16.91883553\,MeV \qquad (5.3)$$

(as in the case of the helium atom (4.19)).

The exchange energy (5.3) (of the quantum of nucleon exchange $q_p = m_p\omega_e$) of the 1st node (Fig. 5.1a) expends on three equal bonds with 2nd, 3rd, and 5th nodes; and the 2nd node, with 1st, 4th, and 6th nodes. Hence the binding energy per node (we mean 1st and 2nd nodes here) is

$$E_{exch,1} = (1/3)E_{exch} = 5.639611843\,MeV/node. \qquad (5.4)$$

Every node of the 3rd, 4th, 5th, and 6th nodes are connected only with one node (1st or 2nd). Hence, the binding energy per node (for nodes from 3rd to 6th) is

$$E_{exch,2} = (1/2)E_{exch} = 8.459417765\,MeV/node. \qquad (5.5)$$

Thus, we have the following internodal binding energies between the nodes of the numbers

(1-2):

$$E_{exch,1-2} = 2E_{exch,1} = 11.27922369\,MeV/bond; \qquad (5.6)$$

(3-1), (5-1), (4-2), (6-2):

$$E_{exch,3-1} = E_{exch,1} + E_{exch,2} = 14.09902961\,MeV/bond \qquad (5.7)$$

Thus, the total energy of internodal exchanges is

$$E_{\text{int},exch} = E_{exch,1-2} + 4E_{exch,3-1} = 67.67534212\,MeV\,. \qquad (5.8)$$

A resulting sum of all constituents of binding energy of the carbon atom ${}^{12}_{6}C$, calculated for q_p: (4.3), (4.17), (5.2), and (5.8), is

$$E_{C,atom} = 6E_D + 2E_{\text{int},shell} + 4E_{ext,shell} + E_{\text{int},exch} = 94.37132212\,MeV\,. \quad (5.9)$$

(Calculations for the exchange charge of a neutron $q_n = m_n\omega_e$ give 94.48781375 *MeV*).

At subtraction of the energy of four valent electrons, $4E_e = 2.022\,MeV$, from (5.9), we arrive at the energy of the carbon ion ${}^{12}_{6}C^{-4}$,

$$E_{C,ion} = E_{C,atom} - 4E_e = 92.34932212\,MeV\,. \qquad (5.10)$$

Thus, the binding energy of the carbon ion ${}^{12}_{6}C^{-4}$, obtained here on the basis of shell-nodal atomic model and the DM, is in well agreement with the binding energy of the carbon nucleus ${}^{12}_{6}C$ equal to $92.488\,MeV$, calculated from the formula on the mass difference, $\Delta E = c^2\Delta m$.

For the derivation described above, the used value of the first constituent of the binding energy of helium and carbon atoms, 2.224 *MeV*, originates from the well-known formula $E_D = c^2\Delta m$ (4.3). It is the binding energy of deuteron D (${}^{2}_{1}H$). We have the right to take this value assuming that according to shell-nodal atomic model the coupled protons and neutrons in nodes are in the form of deuteron.

We will show further that the binding energy of deuteron E_D is also derived on the new basis accepted in this work, just like the derivation of the binding energy of helium and carbon atoms. This aim is achieved on the basis of the supposition that solutions of the wave Eq. (1.2), resulted in the shell-nodal structure of atomic and interatomic (crystal or molecular) spaces (Fig. 1.1), are also valid for the subatomic (intra-nucleon) space. It means that basic constituents of atoms, protons and neutrons, have the same shell-nodal internal structure depicted graphycally in Fig. 1.1. In this connection, we will explain first of all our point of view on the nucleon structure and answer to the

question: what particles of the subatomic level are the main "building bricks" for nucleons?

Let us proceed to elucidate now this question as it is solved in the framework of the Dynamic Model of Elementary Particles.

6. The spectrum of associated masses of elementary particles

The spectrum of associated masses follows from the DM [1, 7]. In dependence on the character of exchange, we distinguish the masses in the longitudinal exchange (at motion-rest in the cylindrical field of matter-space-time), the masses in the transversal exchange (transversal oscillations of the wave beam), and the masses in the tangential exchange (at motion-rest in the cylindrical space-field).

We show here only the derivation of the spectrum of masses (taken from the author's work [1]) playing the role in the longitudinal exchange, because the latter leads to masses of the particles constituent of atoms as, for example, π-mesons, μ-mesons, γ-quanta, *etc*. This will help understanding the concept set forth first in [1] and developed here for the internal spatial structure of nucleons.

Motion-rest in the cylindrical field of matter-space-time can be presented, at a part of the axial line of length dz (Fig. 6.1), (in the simplest case) by the equation of exchange:

$$\rho_z dz \frac{\partial^2 \Psi}{\partial t^2} = -\frac{\partial F}{\partial z} dz , \qquad (6.1)$$

where ρ_z is the linear density of mass, Ψ is the axial displacement, and F is the power of exchange.

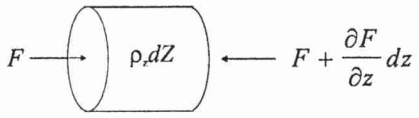


Fig. 6.1. A graph of power of the elementary longitudinal exchange.

Let w be the density of energy of basis and p be the density of energy of superstructure. In a linear approximation, the relative change of energy is $\frac{pS\partial z}{wS\partial z}$, where $wS\partial z$ is the energy of an elementary differential volume $S\partial z$, and $pS\partial z$ is its change.

Assuming that the relative change of energy of exchange is equal to the relative linear change of the elementary volume of space-field, $\frac{pS\partial z}{wS\partial z} = \frac{F\partial z}{wS\partial z} = -\frac{\partial \Psi}{\partial z}$, we obtain $F = -wS\frac{\partial \Psi}{\partial z}$. As a result, the equation of motion-rest takes the form

$$\frac{\partial^2 \Psi}{\partial t^2} = \frac{wS}{\rho_z}\frac{\partial^2 \Psi}{\partial z^2} \qquad \text{or} \qquad \frac{\partial^2 \Psi}{\partial z^2} = \frac{\rho_z}{wS}\frac{\partial^2 \Psi}{\partial t^2}.$$

An element of a beam is $\partial z = c\partial t$; hence,

$$\frac{\partial^2 \Psi}{\partial t^2} = \frac{wS}{\rho_z c^2}\frac{\partial^2 \Psi}{\partial t^2}$$

and

$$c = \sqrt{wS/\rho_z}.$$

If we consider the exchange with the density of energy E at the level of Young modulus, then

$$c = \sqrt{ES/\rho_z}. \qquad (6.2)$$

and

$$\omega = kc = k\sqrt{ES/\rho_z}, \qquad (6.2a)$$

where k is the wave number, which takes a series of discrete values.
Let us determine the characteristic spectrum of frequencies. For the hard-facing alloys, the Young modulus is approximately within $600-680\ GPa$. We select, in the capacity of a calculated magnitude, the characteristic value 654.9, which satisfies the metrological spectrum on the basis of the fundamental measure [22]:

$$E = 6.549 \cdot 10^{11}\ Pa. \qquad (6.3)$$

Let the remaining parameters be equal to

$$l = 2\pi r_0, \qquad \rho_l = m_e / l, \qquad S = \pi r_0^2. \tag{6.3a}$$

Under these conditions, a formula of the characteristic spectrum of frequencies takes the form

$$\omega = 4\omega_0 \cdot r_0 k, \tag{6.4}$$

where

$$\omega_0 = \frac{\pi}{2}\sqrt{\frac{Er_0}{2m_e}} = 6.85091084 \cdot 10^{15}\ s^{-1} \approx \frac{\omega_e}{272.88}. \tag{6.5}$$

The frequency ω_0 is bound up with the fundamental frequency ω_e by the following characteristic ratio:

$$\omega_e / \omega_0 = 272.8103045 \approx 272.8752708. \tag{6.5a}$$

The frequency of the fundamental tone ω_0 is the characteristic frequency of *H*-atomic level. If $l = n\lambda$, then $r_0 k = n$ and

$$\omega_n = 4\omega_0 \cdot n \approx \Delta \cdot 10^{16} n\ s^{-1}, \tag{6.6}$$

where $\Delta = 2\pi \lg e$ is the fundamental quantum-period [22, 23].
The spectrum of frequencies (6.6) defines the spectrum of associated masses of elementary particles with the elementary charge e:

$$M_n = \frac{e}{\omega_n} = \frac{e}{4\omega_0} \cdot \frac{1}{n} = \frac{68.5\, m_e}{n}. \tag{6.7}$$

If $l = n(\lambda/2)$, then $r_0 k = (1/2)n$ and

$$\omega_n = 2\omega_0 \cdot n, \quad M_n = \frac{e}{\omega_n} = \frac{e}{2\omega_0} \cdot \frac{1}{n} = \frac{137\, m_e}{n}. \tag{6.8}$$

At last, at $l = n(\lambda/4)$, it follows $r_0 k = (1/4)n$ and

$$\omega_n = \omega_0 \cdot n, \quad M_n = \frac{e}{\omega_n} = \frac{e}{\omega_0} \cdot \frac{1}{n} = \frac{274\, m_e}{n}. \tag{6.9}$$

Because at $n=1$, a particle of the mass $M_1 = 274 m_e$ is the π-meson, we will call the frequency ω_0 the meson frequency.

At $n=1, 2, 3, 4,$ we have

$$\begin{aligned} 274\, m_e &\Rightarrow \pi\text{-meson} \\ 137\, m_e &\Rightarrow \gamma\text{-quantum} \\ 91.3\, m_e &\Rightarrow \rho\text{-lepton} \\ 68.5\, m_e &\Rightarrow g\text{-lepton} \end{aligned} \qquad (6.10)$$

Two g-leptons form a γ-quantum, three g-leptons compose a μ-meson:

$$205.5\, m_e \Rightarrow \mu\text{-meson.} \qquad (6.11)$$

Particles are able to the mutual transformation. In particular, π-meson, as four g-leptons, can decay following the schemes:

$$\begin{aligned} \pi &\Rightarrow \gamma + \gamma \\ \pi &\Rightarrow \mu + g \\ \pi &\Rightarrow g + g + \gamma. \end{aligned} \qquad (6.12)$$

Evidently, in this series, the first decay is the most probable. The μ-meson and γ-quantum decay in a similar way:

$$\begin{aligned} \mu &\Rightarrow \gamma + g \\ \gamma &\Rightarrow g + g. \end{aligned} \qquad (6.13)$$

The g-lepton had no luck. Having a relatively big mass, it, nevertheless, was eliminated from a series of elementary particles because of the requirements of relativity theory. But afterwards, it was returned to this series under different names: muonic neutrino, electronic antineutrino, *etc.* Such names of g-lepton were stipulated by a concrete interpretation of the reaction. Following [1], we have to recognize that g-lepton exists in the four states:

$$+g, \quad -g, \quad +ig, \quad -ig. \qquad (6.14)$$

The mass of g-lepton is close to a quarter of the fundamental period Δ (in units of the electron mass) [22, 23]:

$$m_g = \frac{1}{4}(2\pi \lg e)\cdot 10^2 m_e \qquad (6.15)$$

that expresses the definite facets of the Eternity.

On the basis of the g-lepton, we compile a sequential series of particles (n-multiple to g):

$$
\begin{array}{lcl}
2g = \gamma & \Rightarrow & g + g \\
3g = \mu & \Rightarrow & \gamma + g \\
4g = \pi & \Rightarrow & \mu + g \quad \text{or} \quad \gamma + \gamma \\
5g = \mathrm{K}_5 & \Rightarrow & \pi + g \quad \text{or} \quad \mu + \gamma \\
6g = \mathrm{K}_6 & \Rightarrow & \pi + \gamma \\
7g = \mathrm{K}_7 & \Rightarrow & \pi + \mu \\
8g = \mathrm{K}_8 & \Rightarrow & \pi + \pi \\
9g = \mathrm{K}_9 & \Rightarrow & \mathrm{K}_8 + g \\
10g = \mathrm{K}_{10} & \Rightarrow & 2\pi + \gamma \\
\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots & & \\
32g = \Lambda & \Rightarrow & n + \mathrm{K}_5 \\
\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots & &
\end{array}
\qquad (6.16)
$$

Here, K_n is the symbol of the particle, expressed in g-leptons.

Experiments detect all these structures of the wave field (under either name or without it) in the form of energetic dispersion in a process of transformations. In 1931, Dirac showed [24] that a field theory could be constructed on the basis of a magnetic monopole g with the following elementary charge

$$q_g = \varepsilon_0 hc / e = 68.5e\,. \qquad (6.17)$$

The division of the charge q_g by the fundamental frequency ω_e gives its mass:

$$m_g = 68.5 m_e\,. \qquad (6.18)$$

Evidently, g-lepton and the Dirac monopole g are the same particle. At that time, the mass of the monopole was determined incorrectly, therefore, g-lepton was not rendered due attention. Knowing the associated mass of Dirac monopole, we obtain the radius of its sphere

$$r_g = \left(m_g / 4\pi\varepsilon_0\right)^{1/3} = 1.706 \cdot 10^{-9}\ cm \approx 4r_e\,. \qquad (6.19)$$

where r_e is the radius of the electron sphere.
We see that r_g is very close to the rational golden section of the fundamental metrological period Δ:

$$r_g \approx \frac{5}{8} 2\pi \lg e \cdot 10^{-9}\, cm. \qquad (6.20)$$

The result obtained gives us the reason to assume that *g*-lepton is a highly stable particle, which possibly is a constituent (like a nucleon for atoms) of protons, neutrons, and other elementary particles of this series. If only this is true, then on the basis of the monopole and the periodic law of space [1, 5], it is possible to compose the spectrum of elementary particles. In such a spectrum, *g*-lepton is a hydrogen analog, γ-quantum is a deuterium analog, μ-meson is a tritium analog, π-meson is a helium analog, *etc.*

7. The g-lepton structure of proton and neutron

Accepting the supposition that nucleons (protons and neutrons) consist of g-leptons, we must recognize that nucleons represent by themselves, by analogy with atoms of the nucleon level, the silicon of the g-lepton level of the atomic number 14 (having 14 nodes according to solutions of (1.2) presented in Fig. 1.1). Indeed, let the mass of g-lepton will be precisely multiple to a quarter of the fundamental period, with respect to the electron mass m_e,

$$m_g = (1/4)2\pi \lg e \cdot 10^2\, m_e = 68.21881769\, m_e. \qquad (7.1)$$

The masses of proton and neutron are, correspondingly,

$$m_p = 1836.1526675\, m_e \qquad \text{and} \qquad m_n = 1838.683645\, m_e. \qquad (7.2)$$

Hence, it is clear that the mass number of nucleons at the g-lepton level must be rather more than 27, because of the relation

$$m_n / m_g = 26.95273397 \qquad (7.3)$$

with taking into account an essential value of the binding energy of g-leptons influenced on the resulting mass of nucleons.

On this basis, we assume that protons and neutrons represent, respectively, at the g-lepton level, two stable isotopes analogous, in nodal structure, to the silicon isotopes, ${}^{28}_{14}Si$ and ${}^{29}_{14}Si$. Their nodal structure, in full agreement with solutions of the wave equation (1.2) (Fig. 1.1), is presented in Fig. 7.1. The

polar-azimuthal functions (according to Eq. (1.3)) of $_{14}Si$ and space disposition of its spherical shells and potential nodes are shown in Fig. 7.2.

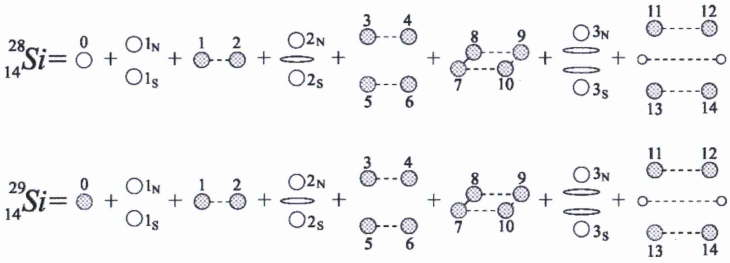


Fig. 7.1. A symbolic design of the shell-nodal structure of silicon, $^{28}_{14}Si$ and $^{29}_{14}Si$, in accordance with the shell-nodal structure of atoms shown in Fig. 1.2.

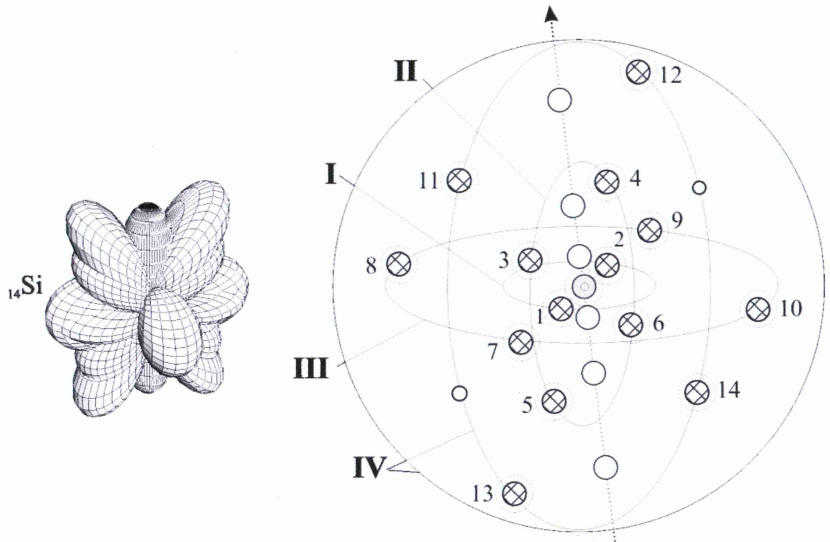


Fig. 7.2. The structure of polar-azimuthal functions (1.3) (at the left) and space arrangement of the 14 polar-azimuthal nodes on four (**I – IV**) spherical shells in $_{14}Si$.

Thus, we regard a neutron of the $^{29}_{14}Si$ structure, in the above meaning, as one of the isotopes of the simplest hydrogen atom $^{1}_{1}H$, protium. The neutron contains additionally one g-lepton in the central polar node (see Fig. 7.1) in

comparison with a proton (of the ${}^{28}_{14}Si$ structure). The neutron is a stable isotope in a bond state, like ${}^{29}_{14}Si$, and decays during $\tau = 1000\,s$ to a proton (the ${}^{28}_{14}Si$ analogous), an electron, and a neutral g-lepton (an antineutrino $\tilde{\nu}$ of nuclear physics):

$$n \rightarrow p + e^{-} + g\,. \qquad (7.4)$$

The shell-nodal structure of ${}^{28}_{14}Si$ (and ${}^{29}_{14}Si$) (Fig. 7.1 and 7.2) is more complicated than the shell-nodal structure of ${}^{12}_{6}C$ (Fig. 2.3), because it has two shells and eight nodes more (at $l = 2, m = \pm 2$ and $l = 3, m = \pm 1$). An internal shell (I) with two polar-azimuthal nodes (1, 2) is the shell of the helium atom (see Fig. 2.2). The second internal shell (II) is the external shell of the carbon atom. The third shell (III) is the external shell of the neon atom. The shell IV is the external shell characteristic for the silicon atom.

According to SNM, the unrepeatable (specific) structure of external shells mainly defines individual properties of atoms distinguishing them from each other. The external shell of ${}_{14}Si$ has two collateral nodes not completed by nucleons in the isotopes of silicon under consideration. Silicon is the first element of the periodic table with such nodes (unnumbered in Fig. 1.1 and other figures), which are metastable states judging from the fact that amplitudes of polar-azimuthal functions determining their positions on shells are essentially smaller that corresponding amplitudes of principal (numbered in presented figures) nodes. This feature provides the motion, in its internal space, not only of particles, which are much less than nucleons, but also the motion of nodal nucleons themselves. Quantum theory interprets this phenomenon as the motion of "holes".

A neutron has the magnetic moment of the value

$$\mu_n = -0.96623640(23) \cdot 10^{-26}\, J \cdot T^{-1} \qquad (7.5)$$

(according to the CODATA [25]). This magnitude is approximately in 1.46 times less in absolute value than the (positive) magnetic moment of a proton. As a system of a proton and an orbiting electron (*i.e.*, being an isotope of protium from the point of view of shell-nodal atomic model), the structure of the neutron with the surrounding field looks conditionally as is depicted graphically in Fig. 7.3.

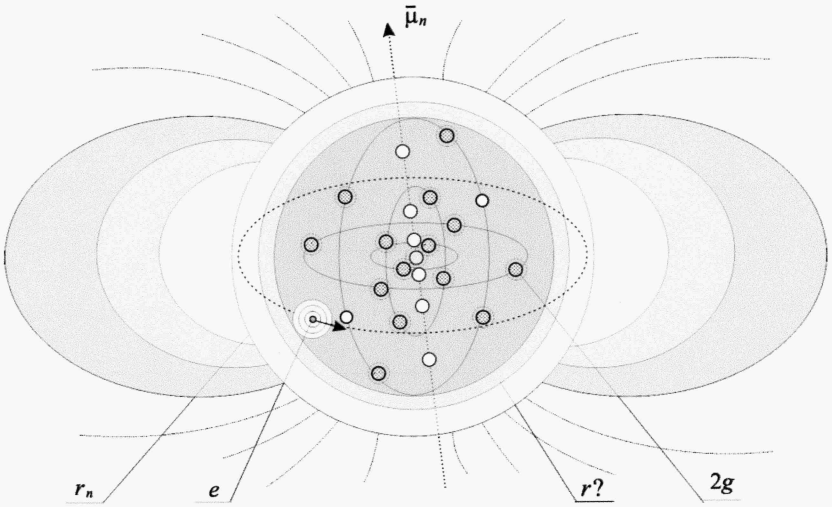


Fig. 7.3. A neutron as an analogous of the silicon atom ${}^{29}_{14}Si$ with the surrounding field; r_n is the neutron outer shell; e is an orbiting electron; $r?$ is the inner radius of the neutron shell; $2g$ is the condition designation of 14 principal polar-azimuthal *potential* nodes completed with coupled g-leptons (the 29th g-lepton is in the central polar *potential-kinetic* node, on the z-axis); $\bar{\mu}_n$ is the magnetic moment of the neutron.

According to the formula of mass defect (4.1), the binding energy of a proton, consisted of 28 g-leptons, is to be

$$\Delta E(p) = c2\Delta m = c^2(28m_g - m_p) = 62.79769638\,MeV\,, \qquad (7.6)$$

so that the binding energy per g-lepton is

$$\varepsilon(p) = \Delta E(p)/A(p) = 2.242774871\,MeV\,, \qquad (7.7)$$

where $A(p) = 28$ is the mass number of a proton at the g-lepton level.

The corresponding values for a neutron ($A(n) = 29$) are

$$\Delta E(n) = c^2(29m_g - m_n) = 71.36715712\,MeV\,, \qquad (7.8)$$

$$\varepsilon(n) = \Delta E(n)/A(n) = 2.460936452\,MeV\,. \qquad (7.9)$$

Now, resting on the shell-nodal g-lepton structure of nucleons, we can proceed to derive the binding energy of deuterium and tritium regarding them as the junction, respectively, of two and three g-lepton systems (pairs)

8. The binding energy of deuterium ${}^{2}_{1}H$ and tritium ${}^{3}_{1}H$

At the joining of two H-atoms, of a neutron and the hydrogen atom ${}^{1}_{1}H$ (protium), the deuterium atom ${}^{2}_{1}H$ is formed. The process of joining results in the penetration of spaces of one nucleon into another, so that the partial overlapping of spherical shells of both nucleons occurs. With this, all g-lepton nodes (Fig. 7.3), filled with coupled g-leptons, of one nucleon and corresponding nodes of another nucleon draw together at the distance r defined by solutions of the wave equation (1.2) (*i.e.*, by the roots of Bessel functions). As a result, 28 helium structures on the basis of binding of approached pairs of coupled g-leptons, like that one shown in Fig. 8.1, are formed.

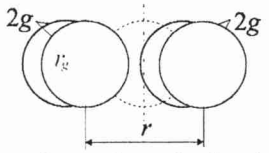


Fig. 8.1. The helium structure formed on the basis of binding of two g-lepton nodes.

The distance r between the nodes is defined by roots of Bessel functions

$$z_{m,n} = kr. \qquad (8.1)$$

The unknown value in this expression is the wave number k equal to the inverse value of the wave radius $\lambda\!\!\!^{-}$,

$$k = 1/\lambda\!\!\!^{-}. \qquad (8.2)$$

The wave radius $\lambda\!\!\!^{-}$ defines the characteristic radii of elementary spherical and cylindrical surfaces described by Bessel functions (8.1) with zero and extremal values. As we saw above, at the *nucleon level*, $k = 1/\lambda\!\!\!^{-}_{e}$, where $\lambda\!\!\!^{-}_{e} = 1.603886538 \cdot 10^{-8}\ cm$ originates from the DM (3.12). The wave radius of

the value $\lambda\!\!\!^{-}_e$ is responsible for the arrangement of *nucleons* in atoms, and hence in crystals, molecules, *etc.* at the definite absolute distances. Accordingly, it is not a random coincidence that the wave diameter of

$$2\lambda\!\!\!^{-}_e \approx 3.2 \cdot 10^{-8} cm \qquad (8.3)$$

is equal, in average, to lattice parameters of crystals. Thus, the wave radius at the nucleon level $\lambda\!\!\!^{-}_n$ is equal to (coincides with) the fundamental wave *radius of exchange*

$$\lambda\!\!\!^{-}_n = \lambda\!\!\!^{-}_e = c/\omega_e, \qquad (8.4)$$

it defines the principal parameters of atomic spaces. Note that

$$\omega_e = e/m_e \qquad (8.5)$$

is the fundamental *frequency of exchange* at the atomic and subatomic levels (the frequency of the "electrostatic field").

Obviously, spaces of the g-lepton level (we mean the internal spaces of nucleons) have another absolute value of the wave radius. The spherical space of a nucleon, like the spherical space of an atom, is also a system of wave shells, but its own whose relative size is defined by the *relative* radius $\rho = kr = z_{m,n}$. The internal proper shells of nucleons with its own nodes, where g-particles are localized, form the superfine discrete structure of atoms.

Thus, we stressed again that solutions of the wave equation (1.2) give only the *relative* radius ρ, and hence, the *relative* value of the corresponding wave radius $\lambda\!\!\!^{-}$. The a*bsolute* value of the latter one must seek from some conditions general for wave processes at different levels.

We will define $\lambda\!\!\!^{-}$ from the scale analogy which exists between wave processes at any levels and, in particular, which must exist between ones at the nucleon and g-lepton levels. The matter is that the fundamental relations existed between the main wave parameters in both scales must keep. One of the fundamental relations exists between the radius of the wave spherical shell of a proton r_p and the fundamental wave radius $\lambda\!\!\!^{-}_e$ of exchange of the proton with other particles and the surrounding field. The theoretical radius of the wave shell of the proton (proton's radius for short), obtained from the formula (3.2) at the condition $(k_e r_p)^2 << 1$ and $\varepsilon_r = 1$, is

$$r_p(th) = (m_p / 4\pi\varepsilon_0)^{1/3} = 0.510578616 \cdot 10^{-8}\, cm. \qquad (8.6)$$

The fundamental wave radius is

$$\lambda\!\!\!^{-}_e = c / \omega_e = 1.603886538 \cdot 10^{-8}\, cm. \qquad (8.7)$$

The ratio of both magnitudes is equal, with some accuracy, to the fundamental constant π,

$$\lambda\!\!\!^{-}_e / r_p(th) = 3.141311617 \approx \pi. \qquad (8.8)$$

This ratio shows that the wave radius $\lambda\!\!\!^{-}_e$, in value, is a half of the length of the equatorial circumference of the wave spherical shell of a proton. Obviously, the same ratio must be valid for the radius of the wave spherical shell of g-lepton, r_g, and the wave radius of the g-lepton level, $\lambda\!\!\!^{-}_g$, so that we have the right to assume that

$$\lambda\!\!\!^{-}_g / r_g(th) = \pi. \qquad (8.9)$$

Hence, for

$$r_g(th) = (m_g / 4\pi\varepsilon_0)^{1/3} = 0.170370509 \cdot 10^{-8}\, cm \qquad (8.10)$$

with $m_g = 6.214420763 \cdot 10^{-26}\, g$ (see (7.1) and (6.15)), the wave radius of the g-lepton level $\lambda\!\!\!^{-}_g$ is

$$\lambda\!\!\!^{-}_g = \pi r_g(th) = 0.534 \cdot 10^{-8}\, cm. \qquad (8.11)$$

We see that the value of $\lambda\!\!\!^{-}_g$ obtained on the basis of a series of approximations is close to the Bohr radius $r_0 = 0.529 \cdot 10^{-8}\, cm$. It is quite possible that more accurate derivations will lead to the equality $\lambda\!\!\!^{-}_g = r_0$. Thus, we cannot exclude the equality of the above parameters: of the Bohr radius and the wave radius of g-lepton level $\lambda\!\!\!^{-}_g$, which both are the basic parameters of the wave sphere atomic space.

Hence, taking the root of Bessel functions, $z_{m,n} = y_{0,1} = 0.89357697$, as in the case of the helium atom, we arrive at the following distance r between two pairs of g-leptons (see Fig. 8.1) in coupling nucleons:

$$r = y_{0,1}\lambda\!\!\!^{-}_{g} = 0.477 \cdot 10^{-8}\, cm\,. \qquad (8.12)$$

It means that wave spherical shells of two H-atoms in the deuterium ${}^{2}_{1}H$ are partially overlapped as is shown in Fig. 8.2 (where $r_p = 0.51 \cdot 10^{-8}\, cm$ (8.6)). Centers of masses of two constituent H-atoms are at the distance $r = 0.477 \cdot 10^{-8}\, cm$, which is some less than the Bohr radius, $r < r_0$.

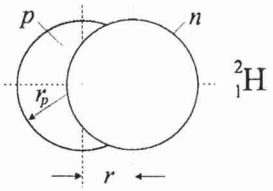


Fig. 8.2. The relative disposition of two nucleons in the deuterium atom ${}^{2}_{1}H$; $r < r_0$.

At such conditions (distance r of the value (8.12)), the binding energy of internodal g-leptons pairs (Fig. 8.1) is

$$E_g = \frac{q_g^2}{8\pi\varepsilon_0 r} = 0.070246848 \cdot 10^6\, eV\,, \qquad (8.13)$$

where

$$q_g = m_g \omega_e = 1.161576228 \cdot 10^{-7}\, g \cdot s^{-1}$$

is the exchange charge of the g-lepton, which is an elementary quantum of exchange at the g-lepton level.

According to the above definition (model), a proton has 28 g-leptons (14 nodes filled every with 2 coupled g-leptons). A neutron, in comparison with the proton, has one more g-lepton located in the central polar node (see Fig. 7.1 and 7.2). Thus, because of all g-leptons take part in the exchange (interaction), we have 28.5 pairs of interacting g-leptons in ${}^{2}_{1}H$. Hence, the resulting binding energy, related to the internodal exchange (interaction) of all g-leptons belonging to two interacting nucleons, is

$$E_{g,exch} = 28.5 \cdot E_g = 2.002\, MeV\,. \qquad (8.14)$$

The obtained value is close to the known value of 2.224 *MeV* (4.3) for the binding energy of a deuteron. It is the main (1st) but not alone constituent of the total binding energy of ${}^{2}_{1}H$ (as in the case of helium and carbon atoms considered above). By accepted analogy between wave processes at two levels under consideration (nucleon and g-lepton), we must take also into account (2nd) the energy of coupling of two g-leptons in their nodes and (3rd) the binding energy of g-lepton nodes with the shells where these nodes are located.

However, we will not derive the rest (2nd and 3rd) constituents here. The derivation of the third one was carried out for helium and carbon atoms. A rough estimate of these constituents of the binding energy on the basis of the analogy between two-nodal structure of helium and two-nodal g-lepton helium structure (Fig. 8.1), will be quite sufficient here.

In this connection, let us assume that the ratio existed between the total binding energy of helium ${}^{4}_{2}He$, 28.3 *MeV*, and its second constituent, the binding energy of coupled nucleons in its nodes (*i.e.*, the binding energy of deuterium), 2.224 *MeV*, keeps the same and for the corresponding g-lepton helium structure shown in Fig. 8.1. In this case, because the total binding energy of all 28 g-lepton helium structures must be equal to 2.224 *MeV* (according to (4.3)), the binding energy of all g-lepton "deuterons" in all g-lepton nodes must be

$$E_{g(2)} = 0.175\,MeV\,. \qquad (8.15)$$

And the binding energy of one g-lepton "deuteron" is

$$\varepsilon_{2g} = 6.25\,keV\,. \qquad (8.15a)$$

Hence, finally, we arrive at the following binding energy of ${}^{2}_{1}H$:

$$E({}^{2}_{1}H) = E_{g,exch} + E_{g(2)} + E_{g(3)} = 2.177\,MeV + E_{g(3)}\,. \qquad (8.16)$$

Obviously, the contribution of the third constituent $E_{g(3)}$, corresponding to the binding energy of all 28 g-nodes with their wave spherical shells will be less than the contribution of the second constituent estimated above. Therefore, we assume that after adding of $E_{g(3)}$ to the total energy we will closer approach to the value 2.224 *MeV*, which follows from the formula on mass defect (4.3).

In addition, let us proceed now to the derivation of the binding energy of tritium. The shell-nodal structure of three joined g-lepton nodes in tritium (belonging to three interacting nucleons), on the g-lepton level, recalls the nodal structure of helium isotope ${}^{6}_{2}He$ (Fig. 8.3). Appearance of two coupled g-leptons in the central polar node slightly changes (increases) the former equilibrium distance r existed between outmost pairs of g-leptons in the g-lepton helium structure shown in Fig. 8.1.

The nearest to the $r = 0.477 \cdot 10^{-8}\, cm$ equilibrium distance between g-lepton nodes, admitted by solutions of the wave equation (1.2), is the distance equal to the wave radius of the g-lepton level, $\lambda\!\!\!^{-}_{g} = 0.534 \cdot 10^{-8}\, cm$. Therefore, we accept this value of the distance between the outermost g-lepton nodes in tritium (Fig. 8.3) for further calculations, so that we have

$$r = \lambda\!\!\!^{-}_{g} = 0.534 \cdot 10^{-8}\, cm,$$
$$r_1 = r_2 = \lambda\!\!\!^{-}_{g} / 2 = 0.267 \cdot 10^{-8}\, cm. \qquad (8.17)$$

We also assume that the exchange interaction in the presented structure exists between every two partially overlapped pairs as is shown conditionally by two arrows in Fig. 8.3.

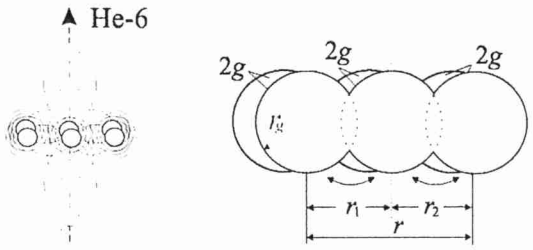


Fig. 8.3. The nodal structure of helium isotope ${}^{6}_{2}He$, and the local structure formed under the joining of three g-lepton nodes in tritium regarded as the *p-n-n* system.

The main constituent of the binding energy in this case, the energy of internodal exchange between two nearest nodes, is

$$E_g = \frac{q_g^2}{8\pi\varepsilon_0 r_1} = 0.140493696\,MeV\,. \qquad (8.19)$$

Hence, the total binding energy of internodal exchange, with allowance for all g-lepton bonds in tritium, is

$$E_{g,exch} = N_{g,bonds} \cdot E_g = 8.07838752\,MeV\,, \qquad (8.20)$$

where $N_{g,bonds} = 57.5$ is the number of internodal g-lepton bonds (*p-n* and *n-n*, 28.5+29) in tritium consisted of two neutron and one proton.

The second constituent, the total binding energy of all g-lepton "deuterons" in tritium, is (according to (8.15))

$$E_{g(2)} = N_{g-nodes} \cdot E_{2g} = 0.2625\,MeV\,, \qquad (8.21)$$

where $N_{g-nodes} = 3 \cdot 14 = 42$ is the number of completed polar-azimuth g-lepton nodes (or the number of coupled g-leptons).

Without the smallest in value contribution of the third constituent $E_{g(3)}$ (related to the binding energy of g-lepton nodes with the shells of their localization), we obtain finally the following magnitude

$$E({}^3_1H) = E_{g,exch} + E_{g(2)} = 8.34088752\,MeV\,. \qquad (8.22)$$

For comparison, the binding energy of tritium, originated from the formula (4.1), is

$$\Delta E = c^2 \Delta m = 8.481821\,MeV\,. \qquad (8.23)$$

Thus, we have an approximate coincidence in the resulting data obtained by two ways different of principle.

9. Conclusion

The obtained results justify in favor of the validity of the new foundations used in this work for the derivation of the binding energies: the shell-nodal atomic model and the dynamic model of elementary particles. Considering hierarchy of particles beginning from an electron up to a nucleon, we can add the following [1].

It is possible to suppose that at the g-level the electron is a very miniature nucleon. Then a g-lepton, judging from its reference mass m_g=68.22m_e, represents a composite atom-molecule of the electron level with the ordinal number $z \approx 32$ (if to rely on the wave equation in the g-lepton space). Indeed, an atom of the periodic table at the nucleon level with the mass number more than 68 ("more", because we must take into account the binding energy of g-leptons) corresponds rather to $_{32}Ge$, than $31Ga$, with the mass numbers of the stable isotopes within 70-76. Moreover, the germanium atom is in the same 4th group of the periodic table as the silicon atom, which is an analogous of nucleons at the g-lepton level.

In that case, it is possible to say that all elementary particles consist finally of electrons. The relation of radii of the electron and g-lepton spheres makes it possible to give one more prediction: the spectrum of particles with measures beginning from the electron to g-quantum masses (the constituent of the vast variety of e-class particles) also exists in nature. The last is the most probable.

By radioactive atomic decay, the rebuilding of atoms occurs, helium the most important fragment of nucleonic shells of atoms is rejected in this case. Two outer shell nodes of helium lost their own electrons. Of course, for all that, the definite modification both on the part of nucleons and on the part of g-particles, runs its course. As a result, fine fractions in the form of γ-rays and miniature nucleons-electrons of right and left polarization are rejected. The latter, in the form of the flow of positive and negative electrons, is also experimentally recorded.

Further, during bombarding of targets by fast protons, decay of nucleons takes place and nucleonic "helium", in the form of π-mesons, is thrown out. In turn, π-mesons decay into two γ-quanta, each of which generates a pair of g-lepton of right and left polarization. In addition, these g-leptons can eject electrons.

The above-considered picture of decay corresponds to reality. Therefore, it is possible to state that in the hierarchy of elementary particles the electrons are at the end of the hierarchy chain of e-class microobjects.

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